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NTZ NACHRICHTENTECHNISCHE ZEITSCHRIFT, vol. 36, no. 4, April 1983, pages 220-223; A.FUCHS et al.: "EVA-Netzabbildung und Routensuche für ein fahrzeugautonomes Ortungs-und Navigationssystem"

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Description

The present invention relates to a navigation system for outputting information required to reach a destination.

Description of the Related Art:

Recently, navigation systems for vehicles have been developed which are designed to output on a display various types of information required for a driver who is unfamiliar with a particular area to reach a destination and thereby guide the driver to the destination.

Conventional nagivation systems fall into two types: the location method and fixed route method.

The location method was proposed in, for example, the specification of Japanese Patent Laid-Open No. 58-115600. In this method, a map stored in an external memory is read out and is stored in an image memory by an arithmetic and logic unit constituted by a microcomputer. Also, the arithmetic and logic unit calculates the locus of a vehicle using data input from azimuth and distance sensors, and displays the map and the locus of the vehicle on a display.

Japanese Patent Laid-Open No. 62-142216 discloses the fixed route type navigation system. In this method, a course that is to be followed from a starting point to a destination is set beforehand, and the driver is guided in accordance with the course set. The next intersection along the course where the vehicle is to turn is indicated in this method by numerically or graphically displaying the distance remaining before that intersection is reached. So, the driver looks at the course indicated on the map and knows the intersection where he should turn. Altenatively, the driver looks at the numerals or graph displayed to ascertain the distance remaining to that intersection, and thus knows the intersection where the vehicle should be turned.

In both the location method and the fixed route method, the information required to guide a vehicle to a destination such as map data or intersection data is stored in one external memory such as a floppy disk, a CD-ROM, or a magnetic tape. Guided navigation to a plurality of areas (e.g., to Nagoya and Kyoto) is made possible by using corresponding external memories which are switched with each other as required.

In both of the above-described conventional navigation systems in which the information required to guide a vehicle to one area, e.g., Kyoto, such as map data or intersection data, is stored in the external memory beforehand, not all the information is stored in the external memory. Also, it is very difficult to store all the information in the external memory, both in terms of storage capacity and the calculation ability of the central processing unit. Even if all the necessary information is input in the memory, a large amount of information makes selection of a destination very difficult. In both of these navigation systems, it is impossible to guide a vehicle if the memory does not contain the information on a desired starting point or destination beforehand. In that case, a driver has to go to a nearby starting point which is stored in the memory without the assistance of the navigation system. He also has to go to his true destination by himself after he has reached the destination input in the memory beforehand.

Further, modification, addition and deletion of the information stored in an external memory such as map data or intersection data requires a great deal of time and expense.

The above-described location method has its own problem in that, in a case where it is necessary to turn at an intersection indicated on a map displayed on the display device, it may be impossible for a driver to indentify an intersection where the vehicle is approaching with the one indicated on the map, due to errors accumulated in the measured running distance or direction. The driver may pass an intersection where he should turn, or the present position on the map may not correspond with a road on the map.

In the fixed route method, since the course to be followed from a starting point to a destination is set beforehand and the vehicle is guided in accordance with the course set, it is difficult to change the destination during travel. Further, if, for example, a wrong turning is made and the driver deviates from the original course, it is impossible to continue travelling under the guidance of the navigation system unless the vehicle can be returned to the course originally set. Furthermore, it is necessary to judge whether a vehicle has passed a predetermined intersection as planned on the basis of running distance data prepared by a distance sensor or data representing right or left turns which is obtained through a steering sensor. In consequence, any detection errors which occur during actual travel may cause misjudgement.

In order to obviate these problems, the present inventors filed an application in respect of a navigation system for outputting information required to guide a vehicle to a destination at a plurality of points (in Japan under Japanese Patent Application No. 62-307805 and in the U.S.A. on October 20, 1988). In this system, the coordinates of a plurality of points are set and the information required to reach the destination is calculated at each of these points. This method (hereinafter referred to as the coordinate origin method) has the advantage that it is possible to change a destination during travel

and that the course followed to a destination can be searched relative to any of the plural points. However, as stated above, it is difficult to input all the information required to guide a vehicle to a particular destination. It is therefore essential to decide properly which information is to be stored and how the stored information is to be used.

It would therefore be desirable to provide a navigation system which can obviate the aforementioned problems, which enables a vehicle to be guided to a destination from any starting point by preparing a standard data base as an internal or external memory and an individual data base that complements this standard data base as an external memory, and which enables the data to be updated relatively easily.

There is known, for example from PATENT ABSTRACTS OF JAPAN, vol. 11, no. 334, (P-631) [2781], 31.10.87; & JP-A-62116210 a navigation system for a vehicle comprising: a first external storage means for storing first guidance data including road and intersection data; a second storage means for storing second guidance data; said guidance data being linked to said first guidance data; output means for outputting guidance information; and CPU means for receiving said first and second guidance data from said first and second storage means, supplementing said first guidance data by said second guidance data, and outputting said guidance information based on said supplemented guidance data via said output means. In this arrangement the first external storage means stores map information and the second storage means which is in the form of a floppy disc may store additional information to be displayed together with the map information. Such additional information may for example he picture cage information and the positional adjustment of the information to be displayed from the two storage means must be effected manually. Thus, such an arrangement cannot provide for automatic updating of redundant map information that may exist in the first storage means by replacement map information that may overlap with the redundant information to be replaced.

Other means for providing information to be displayed from more than once source are known for example from PATENT ABSTRACTS OF JAPAN, vol. 12, no. 185, (P-710) [3032], 31.05.88; and JP-A-62293120; PATENT ABSTRACTS OF JAPAN, vol. 11, no. 366, (P-641)[2813], 28.11.87; JP-A-62138719, and DE-A-3323704.

It is an object of the present invention to provide an improved navigation system of the kind set out above, wherein overlapping map data from two sources can be coordinated automatically to overcome the problems already outlined above.

This object is achieved by the features of the characterising clause of Claim 1.

In one example of the present invention, the first external storage device, which may be a CD, stores data representing the standard map of an area and the data required for guiding a vehicle in that area, and the second external storage device, which may be an IC card, stores individual data which cannot be complemented by the standard map data and the guidance data. In an actual operation, the CD stores the data representing the major route map of Japan or any area in the world and the data required for guidance. The IC card stores the data on the map of the vicinity of a hotel, a gas station or a rental car office in a particular area, and the data needed to guide a vehicle in that vicinity. IC cards are prepared for various objectives. For example, IC cards which store data needed to guide a user on a sightseeing trip or that needed to guide a user to commercial premises, a station or an airport may be prepared. Th IC cards may additionally store traffic information or weather information. The hotels, gas stations and rental car offices may serve as information centers where data is input into the card and data in the card is updated, and where these cards are sold and supplied to users. Thus, a user is first led to a target area using a CD. After arriving the area, he receives an IC card at the information center, and is then guided to a target location with the assistance of that card. Alternatively, data which is prepared in an information center may be input to the RAM of the CPU or to the IC card by a communication device such as a car telephone through a telephone line. In that case, it is not necessary to prepare CD or IC cards which store data beforehand.

Thus, in the present invention, since only the detailed data which is adequate for a desired area and a desired objective can be stored in the IC card which serves as the second external storage device, the data stored in the first external storage device which is a CD can be simplified. Further, modification and addition of data is performed on that stored in the IC card, and this facilitates maintenance operation. Furthermore, since data is stored in both CD and IC card, the number of data stored can be reduced. This makes the operation simpler and enables a data that meets the demand of a user to be selectively supplied to the user. As a result, guided navigation is made possible from any starting point to a destination by preparing a standard data base and an individual data base that complements the standard data base as the external memories. Further, data updating can be made relatively easy.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 (a) is a block diagram of a navigation system, showing a first embodiment of the present invention;

Fig. 1 (b) shows the structure of an external storage device;

Figs. 2, 3, 4, 5, 6 and 7 show the structure of data stored in the first external storage device;

Figs. 8, 9, 10, 11, 12 and 13 show the structure of data stored in the second external storage device;

Fig 14 is a flowchart of the control processing executed in the coordinate origin method;

Fig. 15 is a flowchart of route searching processing;

Fig. 16 is a flowchart of destination inputting process;

Fig. 17 is a flowchart of destination setting process;

Figs. 18 and 19 are flowcharts of a data searching process executed in the first embodiment of the present invention;

Figs. 20, 21, and 22 are flowcharts of route searching process;

Figs. 23 and 24 show the structure of data, showing a second embodiment of the present invention;

Figs. 25 and 26 are flowcharts of a data searching process executed in the second embodiment of the present invention;

Fig. 27 shows the structure of data, showing a third embodiment of the present invention;

Figs. 28, 29 and 30 (a) are flowcharts of a data searching process executed in the third embodiment of the present invention;

Fig. 30 (b) explains a method of judging whether a data is within an area or outside of the area;

Figs. 31 and 32 show the structure of data, showing a fourth embodiment of the present invention;

Figs. 33, 34 and 35 are flowcharts of a data searching process executed in the fourth embodiment of the present invention; and

Figs. 36 and 37 are flowcharts, showing another types of navigation system to which the present invention is applied.

Embodiments of the present invention will be described below with reference to the accompanying drawings.

Referring first to Fig. 1 which is a block diagram of a first embodiment of a navigation system according to the present invention, a system comprises a man-machine interface 1, a present position checking unit 2, an external storage unit 3, and a central processing unit 4.

The man-machine interface 1 includes at least a display device 5 and an inputting device 6. The display device 5 may comprise a CRT, a liquid crystal display or the like. The inputting device 6 may comprise a keyboard, a touch-panel, a light pen, a mouse or the like. The man-machine interface 1 optically includes a speech output device 7 such as a speaker and a communication device 9 such as a car telephone.

The present position checking unit 2 employs either a receiver 10 for a global positioning system (GPS) which measures a position utilizing an artificial satellite, a beacon receiver 11 for receiving the positional information from a beacon disposed on a road, a geomagnetic sensor 12, a distance sensor 13 or a steering sensor 15. Both of the GPS receiver 10 and the beacon receiver 11 can be used as a single unit to measure the present position. However, the geomagnetic sensor 12 and the steering sensor 15 must be used together with the distance sensor 13.

The external storage unit 3 consists of a first external storage device 16 and a second external storage device 17. Floppy disks, CD-ROMs, optical disks, magnetic tapes, IC cards, or optical cards may be used as the first and second storage devices 6 and 7. However, a CD-ROM having a large storage capacity may be preferably used as the first external storage device 16, and the second external storage device 17 may be of the card type which can be manufactured at a low cost. The first external storage device 16 which may be a CD stores data on the standard map of a particular area and the data required to guide a vehicle in that area, and the second external storage device 17 which may be an IC card stores individual data which cannot be complemented by the data on the standard map and that required for guidance. More specifically, as shown in Fig. 1 (b), data on the major route map of Japan or of any area in the world, as well as the data required for guidance are input in the CD, and data on the map of the vicinity of a hotel, a gas station or a rental car office located in a certain area and data required for guidance are input in the IC card. IC cards may be prepared for various objectives, e.g., IC cards storing information required to guide a user on a sightseeing trip or that required to guide a user to commercial premises, a station or an airport may be prepared. IC cards may additionally store traffic information, weather information and the like. The hotels, gas stations and rental car offices may serve as information centers where data is input or data in the IC card is updated, and where IC cards are sold or supplied to users. Thus, a user is first led to a target area using a CD. After arriving at that area, he receives an IC card at the information center and is then led to a destination with the assistance of that IC card. It is to be noted, however, that the data representing the map and that

required for guidance are structured in different ways in the location method, the fixed route method and the coordinate origin method, as will be described later.

This embodiment employs two external storage devices 16 and 17 as its external storage unit . However, the standard information required for guidance may also be stored in a storage device within the CPU 4 rather than in the first external storage device 16.

Once a user has input a destination through the inputting unit 1, the CPU 4 reads out the data representing a map and that required for guidance from the external storage unit 3, operates the data, stores the operation results in a RAM 20, and outputs the necessary results to the display device 5 or the speech output device 6 in accordance with a navigation program stored in a ROM 19. The data required to guide a user which is output from the external storage unit 3 represents the data required for the vehicle to reach the destination. To a vehicle which is located at an intersection on a specific route, data representing a right turn or a left turn that the vehicle should make at a subsequent intersection is output. In a case where there is another intersection very close to a first intersection where the vehicle turns, the data representing the direction in which the vehicle should turn at the first intersection and that representing a traffic lane in which the vehicle should travel after it has turned at the first intersection may be output as information required for guidance. Alternatively, the direction in which the vehicle should turn at the second intersection may also be output as information required for guidance.

In addition, the data which is prepared in an information center 21 may be input by the communication device 9 such as a car telephone through a telephone line, the input data being entered to the RAM of the CPU 4 or in an IC card through a modem 22. In this case, it is not necessary to store data in an IC card beforehand. A hotel, a gas station or a rental car office in an area may be able to serve as the information center 21. Alternatively, an information center which acts as a service center for the entire region or a metropolitan area may be installed.

Next, the structure of the data employed in the navigation system for the vehicle according to the present invention, as well as the control process executed in the navigation system will be described below.

First, an example in which the present invention is applied to the coordinate origin method will be described.

Figs. 2 to 7 show the structure of the data stored in the first external storage device (e.g., in a CD) employed in the navigation system for the vehicle according to the present invention.

Fig. 2 (a) shows a list of relatively broad regions, e.g., a list of prefectures. Prefecture number 01 represents Aichi Prefecture. The list contains prefecture names in Chinese character, Hiragana and Romaji, the address of list of cities (the starting address thereof), the number of cities listed, the major intersections/landmarks numbers and so on. Fig. 2 (b) shows a list of wards or cities which is the data narrower than the region data. The list contains city names in Chinese character, Hiragana and Romaji, the address of list of sub-districts (the starting address thereof), the number of sub-districts listed, the major intersections/landmarks numbers and so on. Fig. 2 (c) shows a list of sub-districts, which is the data narrower than the ward or city data. The list contains sub-district names in Chinese character, Hiragana and Romaji, the address of list of intersections (the starting address thereof), the number of intersections listed, the address of list of landmarks, the number of landmarks listed, the major intersections/landmarks numbers and so on. Such hierarchically structured data enables the list of prefectures, the list of cities and the list of sub-districts to be searched for a starting point, a present position or a destination input in that order. Further, it enables the major intersection or landmark to be separately searched in the list of prefectures, in the list of cities and in the list of sub-districts.

Figs. 3 (a) and (b) respectively show a list of intersections that are located in each sub-district and a list of landmarks located in each sub-district. The lists contain the intersection numbers and landmark numbers, respectively. Figs. 3 (c) and (d) respectively show the sort files of Romaji and Hiragana. The files contain alphabetically arranged prefecture names and the addresses of data representing the prefectures, and this enables the time required for search of the name of a place to be shortened.

Fig. 4 shows an example of numbering of roads and intersections on a map. In two sub-districts, there are 21 intersections from 1 to 21, and there are 46 roads from 1 to 46. If two-way traffic is allowed on a road, two different numbers are affixed to that road. If the road is a one-way road, one number is affixed to that road.

Fig. 5 shows an example of intersection data. The data includes the name of an intersection which corresponds to a intersection number, the coordinate (the latitude and a longitude), the road number which starts from an intersection and which has the smallest number, the road number which ends at that intersection and which has the smallest number, and data representing whether or not an intersection has a signal. A route can be searched and various navigation information can be

displayed on a display using this data.

Fig. 6 shows an example of landmark data. The data includes the name of a landmark which corresponds to a landmark number, (e.g., the name of a river, the name of a building or the name of a bridge), the coordinate and the intersection numbers located adjacent to a landmark.

Fig. 7 shows an example of road data. As shown in Fig. 4, each road has its own number or numbers, and the road data contains the starting point and ending point (the intersection numbers) of each road number, one of the roads which start from the same starting point, one of the roads which end at the same ending point, the width of a road, no-passage data, not guided data (e.g., no data is output when a vehicle proceeds from a road number 1 to a road number 3) and the photo number of an intersection.

Next, the structure of data stored in the second external storage device (e.g., an IC card) will be described below with reference to Figs. 8 to 13.

Fig. 8 shows the intersections and roads which are added to the CD data. The roads to be added are indicated by a broken line, and added intersections and roads are affixed with sub-numbers, the road numbers being enclosed by an ellipse. As shown in Fig. 8, intersections from 1-1 through 1-3 and roads from 1-1 through 1-12 are added, and roads 22, 23, 29, 44, 45 and 46 are eliminated from the original map.

Figs. 9, 10 and 11 respectively show intersection data, landmark data and road data to be added as the result of the addition of the intersections and roads shown in Fig. 8. The data contains the newly added data and data representing the modification of the intersection data and road data caused by the addition.

Fig. 12 (a), (b) and (c) respectively show modified data on the list of sub-districts, the list of intersections and the list of landmarks which are changed as the result of addition of intersections and roads shown in Fig. 8.

Figs. 13 (a) to (c) respectively show road data, intersection data and landmark data to be deleted. Fig. 13 (d) shows the data representing the starting address of the deletion data in the memory, and Fig. 13 (e) shows the data representing the starting address of the modified data in the memory. The starting address 0 indicates that the data is not deleted or changed.

Control of the thus-arranged navigation system which employs the coordinate origin method will be described below with reference to Figs. 14 to 22.

Referring first to Fig. 14, a driver inputs a destination (in step 31). Once the destination has been input, the system is switched into route search mode in which data required to guide a user to the destination is set with respect to all the points other than the destination (in step 32). After the route has been searched, the system switches to present position input mode in which the present position is input (in step 33), and the direction in which the vehicle proceeds from that point is then output (in step 34). Thereafter, an intersection confirmation trigger is input (starting of a vehicle is input in step 35), and the data required for the vehicle to reach the destination at a subsequent intersection is then output (in step 36). Next, it is monitored which is input next, an intersection confirmation trigger or a present position input button signal (in step 37). If the intersection confirmation trigger is input, the processing returns to step 36. If the signal input is the present position input button signal, the flow returns to step 33. In other words, in this system, when the vehicle is running as guided, a trigger is input every time the intersection is confirmed. If the vehicle passes the intersection where it is to turn and deviates from the course, the present position input button is pressed. Thus, every time the trigger is input, data required for the vehicle to reach the destination at an intersection along the route is output. When the present position input button is input, the system switches to present position input mode.

As shown in Fig. 15 (a), Once the system has been switched to route search mode, a destination is set in a work area (in step 39), and the directions in which the vehicle may proceed are set starting from the intersections closest to the destination (in step 40). More specifically, the directions d_1 are set first with respect to the intersections closest to the destination, and the directions d_2 are then set with respect to the second closest intersections, as shown in Fig. 15 (b). The route search may also be performed after the step 33 shown in Fig. 14 has been executed. In that case, the route search is performed every time the present position is input. In a trigger input, since the data required for the vehicle to reach the destination is output in accordance with the route set by the route search, the number of intersections that are located on the route is limited. Therefore, the system may also be arranged such that only the data required at these intersections is set.

Once a destination has been input in step 31, it is first determined as to whether or not the name of a region is input in step 51, as shown in Fig. 16. Subsequently, the list of prefectures, the list of cities and the list of sub-districts are successively searched to fetch the addresses of the intersection list and landmark list using a combination of prefecture, city and sub-district which is input (in steps 52 to 58). If the name of a region is not input, a code number is input in step 60. Thereafter, target intersection setting route is executed in step 59. A prefecture, a city and a sub-district may be input

through a touch panel or by pressing Romaji or Hiragana keys. A region is selected on the touch panel when that portion of the touch panel is touched.

In the target intersection setting subroutine executed in step 59 in Fig. 16, one of the intersections or landmarks which is the closest to the starting point is searched from the list of intersections and the list of landmarks (route search), as shown in Fig. 17.

Figs. 16 and 17 are respectively flowcharts of processings generally executed when a route is searched and when the target intersection is searched. However, the data employed in this embodiment consists of CD data stored in the first external storage device 16 and IC card data stored in the second external storage device 17. The processing of these two types of data will be described now with reference to Figs. 18 and 19.

Fig. 18 is a flowchart of a sub-district search conducted on these two types of data. First, it is determined in step 61 whether or not there is an IC card. If the answer is negative, the list of sub-districts in the CD [which is shown in Fig. 2 (c)] is searched for the sub-district in step 62, the data on the sub-district is fetched, and a flag indicating that the obtained data is a CD data is set (in steps 63 to 65). If there is an IC card in step 61, the list of sub-districts in the IC card [which is shown in Fig. 12 (a)] is searched for the target sub-district, and it is then determined whether or not there is the sub-district (in steps 67 and 68). If the answer is negative, the processing goes to step 62. On the other hand, if the answer is affirmative, the data on the sub-district is fetched, and a flag indicating that the obtained data is an IC card data is set (in steps 69 and 70).

Fig. 19 is a flowchart of a read of the intersection data. First, it is determined whether or not there is an IC card in step 71. If the answer is negative, the intersection data stored in the CD (shown in Fig. 5) is searched for a necessary intersection and the target intersection data is fetched in step 72. Thereafter, a flag indicating that the obtained data is a CD data is set in step 73. If it is determined that there is an IC card in step 71, the added intersection data stored in the IC card (shown in Fig. 9) is searched for a necessary intersection in step 74. Subsequently, it is determined in step 75 whether or not the necessary intersection data is listed. If the answer is affirmative, the intersection data is fetched, and a flag indicating that the obtained data is an IC card data is then set (in steps 76 and 77). If it is determined that there is no intersection in step 75, the starting address of deletion data stored in the IC card [shown in Fig. 13 (d)] is fetched in step 78. If it is determined that the starting address is 0 (indicating that there is no deletion) in step 79, the processing proceeds to step 72. If the starting address is 0, search is conducted on the deleted intersection file stored in the IC card [shown in Fig. 13 (b)] in step 80. If the file contains the intersection, a flag indicating that the intersection is deleted is then set (in steps 81 and 82).

Search is conducted on the road data and the landmark data in the same manner as that in which the intersection data is searched. That is, search is conducted first on the data stored in the IC card first and then on the data stored in the CD.

Fig. 20 is a flowchart of route searching processing which is executed on the basis of the data which is read out from the CD and IC card. First, in step 151, FF is assigned to the distance L (c) from the starting point with respect to all the intersections, and the search flag F (c) is set at 0 (indicating not searched)(the distance L (c) and search flag F (c) are initialized). Next, the distance from the starting point is assigned to the distances of the intersections located adjacent to the starting point, and the flags of the intersections located adjacent to the starting point are set at a search flag 1 (indicating that the intersection is being searched) in step 152. Further, the number of the road that the vehicle has passed after it started from the starting point is set. In step 153, an intersection whose flag is not 2 (which indicates that the search is over) and which has the smallest distance is found. Subsequently, in steps 154 and 155, the surrounding road search subroutine is executed. If there is a surrounding road, the optimal route condition setting subroutine is executed (in step 156), and the number of the intersection located at the end of that road and the distance L of the road are input in step 157. Thereafter, in step 158, this distance L is added. If the result is larger than the distance from the starting point, that distance is set as the distance from the starting point, the search flag is set at 1 (indicating that the intersection is being searched), and the number of that road is input (in steps 159 and 160). Next, the step 154 is executed, and if it is determined that there is no surrounding road in step 155, the search flag is set at 2. Thereafter, the ending condition confirmation subroutine is executed, thereby completing the route search processing (in steps 161 to 163). Thus, the shortest route that is followed from the starting point to the destination is set.

Fig. 21 is a flowchart of the surrounding road search subroutine which is executed in step 154 in the processing shown in Fig. 20. First, it is determined whether or not the search of the surrounding road is executed for the first time in step 171. If the answer is affirmative, the numbers of the roads which start from the current intersection are fetched from the intersection data and are stored in

step 172. Next, in step 173, the no-passage roads that correspond to the roads that lead to this intersection are fetched from the road data, and it is then determined in step 174 whether or not the roads fetched this time are identical with the no-passage roads explained with reference to Fig. 7. If the answer is no, the fetched roads are stored as the surrounding roads. If it is determined that it is not the first time that the search of the surrounding road is executed in step 171, or if the answer of the step 174 is affirmative, the road having the same starting point as that of the previously searched road and having a subsequent number is fetched from the road data in step 176. Thereafter, in step 177, it is determined whether or not the previously searched road is identical with the road which is fetched this time. If the answer is negative, the processing proceeds to step 173. If the answer is affirmative, the processing goes to step 178 where it is determined that there is no surrounding road.

Fig. 22 is a flowchart of the optimal route condition setting subroutine executed in step 156 of the processing shown in Fig. 20. First, the width and length of the surrounding road are read in from the road data, and it is then determined whether or not the width is, for example, 1 m or less (in steps 201 and 202). If the width exceeds 1 m, the processing proceeds to step 203. If the width is 1 m or less, it is, for example, doubled in step 203, and the no guided data on the roads that lead to the currently searched intersection is read in from the road data in step 204. Thereafter, it is determined in step 205 whether or not there are surrounding roads that are identical with the no guided data. If there is such a surrounding road, the processing goes to step 207. If there is no such a surrounding road, 100 m, for example, is added to the length of the road, and the result is then added to the virtual distance of the currently searched intersection from the starting point to obtain the virtual distance of the intersection located at the end of the surrounding road in step 207.

Next, another embodiment of the present invention will be described below with reference to Figs. 23 to 26. In the first embodiment, search is directly conducted on the CD data and IC card data, as has been described with reference to Figs. 18 and 19. On the other hand, this embodiment prepares a comparison list of the CD data and IC card data.

Fig. 23 (a) shows the starting address of the memory where the comparison list data is stored, Fig. 23 (b) a comparison list for sub-districts which contains the order of modified data for each sub-district, and Fig. 23 (c) shows a comparison list for road data. An integer in the column of the order of modified data represents the order taken by the data when it is stored in the memory, -1 and 0 in the column indicating that the data is deleted and that the data is not changed, respectively. Figs. 24 (a), (b) and (c) respectively show a comparison list for the intersection data, a comparison list for the landmark data, and the starting address of the modified data.

The above-described comparison list data may be created by operating data within the CPU. In that case, the CD data on all the intersections is read out and the data read outr is compared with the corresponding IC data so as to determine if there is an addition or deletion of the data. The thus-created comparison list is then stored in the RAM or the like.

Figs. 25 and 26 show the search processings which employ the above-described comparison lists.

In the sub-district search processing shown in Fig. 25, the sub-district is first searched in the sub-district list file in the CD in step 92, and it is then determined whether or not there is an IC card in step 92. If there is no IC card, data on the sub-district [shown in Fig. 2 (c)] is fetched from the CD, and a flag indicating that the obtained data is a CD data is set (in steps 93 to 96). If it is determined that there is an IC card in step 92, it is determined whether or not the sub-district is listed in step 97. If the sub-district is listed, the starting address of the list of sub-districts is fetched from the comparison list starting address file in the IC card [shown in Fig. 23 (a)] in step 98. Subsequently, it is determined whether or not the starting address is 0 in step 99. If the starting address is 0 (which means that there is no change), the processing goes to step 95. If the starting address is not 0, the order of the modified data on that sub-district is fetched from the comparison list for sub-districts [shown in Fig. 23 (b)] in step 100. Next, in step 101, it is determined whether or not the order is larger than 0. If the answer is no (which means that there is no change), the processing goes to step 95. If the answer is yes, the stored address of the modified data is obtained and the data on the sub-district [shown in Fig. 12 (a)] is fetched from the IC card in step 102, and a flag indicating that the data is an IC card data is set in step 103. If it is determined in step 97 that the sub-district is not listed, the sub-district modified data [shown in Fig. 12 (a)] is searched for th sub-district. If the sub-district is listed, a flag indicating that the data is an IC card data is set in step 106.

Fig. 26 is a flowchart of the read of the intersection data. First, it is determined in step 111 whether or not there is an IC card. If there is no IC card, the intersection data in the IC (shown in Fig. 5) is searched to fetch the necessary intersection data in step 112, and a flag indicating that the data

is an CD data is set in step 113. If it is determined in step 111 that there is an IC card, it is determined in step 114 whether or not the intersection is an added one. If it is not an added intersection, the starting address of the list of intersections is fetched from the comparison list data starting address file [shown in Fig. 23 (a)] in the IC card in step 115. Subsequently, it is determined in step 116 whether or not the starting address is 0. If the starting address is 0 (which means that there is no change), the processing goes to step 112. If the starting address is not 0, the order of the modified data on that intersection is obtained from the intersection comparison list file [shown in Fig. 24 (a)] in step 117. Next, it is determined in step 118 whether or not the order is larger than 0. If it is not larger than 0 (which means that there is no change), the processing goes to step 112. If the order is larger than 0, the stored address of the modified data is obtained and the intersection data [shown in Fig. 12 (a)] is fetched from the IC card in step 119, and a flag indicating that the data is an IC card data is then set in step 120. In step 121, it is determined whether or not the order obtained in step 171 is a negative value. If it is, a flag indicating that the intersection is deleted is set in step 122. If it is determined that the intersection is an added one in step 114, the intersection data in the IC card (shown in Fig. 9) is searched to fetch the intersection data in step 123, and the processing then proceeds to step 120.

Still another embodiment of the present invention will be described below with reference to Figs. 27 to 30. Whereas the modified data stored in an IC card is searched directly or by using a comparison list in the above-described embodiments, the present embodiment involves designation of a region where the modified data exists.

Fig. 27 (a) shows a method of designating a modified region using the most northerly latitude, the most southerly latitude, the most easterly longitude, and the most westerly longitude, Fig. 27 (b) shows a method of designating the modified region using a polygon defined by latitude and longitude, Fig. 27 (c) shows a method of designating a modified region using a polygon defined by roads, and Fig. 27 (d) shows a method of designating a modified region using the intersections or landmarks.

Fig. 28 is a flowchart of processing of search of intersection data which is employed by this region designation method. In step 211, the intersection data (shown in Fig. 5) is fetched from the CD, and it is then determined in step 212 whether or not there is an IC card. If there is no IC card, a flag indicating that the data is a CD data is set in step 213. If there is an IC card in step 212, it is determined whether or not the intersection is within the modified region designated by any of the methods shown in Fig. 27. If the intersection is outside of the modified region, the processing proceeds to step 213. If it is within the region, the added intersection data (shown in Fig. 9) stored in the IC card is searched for a necessary intersection (in step 216). If it is determined in step 217 that the intersection is listed, the intersection data is fetched from the IC card in step 218, and a flag indicating that the data is an IC card data is then set in step 219. If it is determined in step 217 that the necessary intersection is not included in the added intersection data in the IC card, the starting address of the intersection data is fetched from the deletion list data starting address [shown in Fig. 13 (d)] in step 230. Thereafter, it is determined in step 231 whether or not the starting address is 0. If it is not 0, the deleted intersection list file shown in Fig. 13 (b)] in the IC card is searched. If the intersection is contained in the file, a flag indicating that the intersection is deleted is set (in steps 233 and 234).

Fig. 29 is a flowchart of road data search processing employed in the region designation method. The contents of the processing are the same as those shown in Fig. 28, description thereof being omitted.

Fig. 30 (a) is a flowchart of processing of determining whether or not the data is within a region which is executed when the region is designated using the roads shown in Fig. 27 (c).

First, the road numbers required to designate a region are read from the IC card, and the data read is assigned to LN(1) ... LN(n) in step 271. Next, the starting points and ending points of the roads designated by LN(1) ... LN(n) are read from the CD, and the data read which represent the starting points is assigned to LNS(1) ... LNS (n) while the data representing the ending points is assigned to LNE (1) ... LNE (n) (in step 272). Subsequently, the stating points and ending points are compared with each other so as to check whether or not the roads are connected (in steps 273 and 274). If the roads are not connected, a data inputting error flag is set (in step 281). If the roads are connected, it is determined in step 275 whether or not the starting point of the first road is identical with the ending point of the last road, i.e., whether or not the intersection is surrounded by the roads. If it is not surrounded by the roads, a (n + 1)th road is virtually created so that the intersection can be surrounded by the roads in step 280. Thereafter, in step 276, a point of intersection where each road crosses the latitude line that passes the intersection is calculated, and the number XN of points of intersection located on the right side of the intersection is then counted. Next, it is determined in step 277 whether or not this XN is an odd number, and a flag indicating that the intersection is within

the region or outside the region is accordingly set (in step 278 or 279). Fig. 30 (b) shows examples in which the intersection is within the region and outside the region.

As in the case of the method which utilizes a comparison list and which is described with reference to Figs. 25 and 26, a comparison list may be made beforehand by checking if each of the intersections is located outside the region or if it is a modified data, and the resultant comparison list may be stored in the RAM or the like.

Still another embodiment of the present invention will be described below with reference to Figs. 31 to 35. Whereas each of the above-described embodiments involves storage of modified names of places, intersections and roads in an IC card, modified geographical feature data is stored in an IC card in this embodiment.

Fig. 31 shows the structure of geographical feature data stored in a CD. The geographical data includes the most northerly latitude, the most southerly latitude, the most easterly longitude, the most westerly longitude, adjacent screens G1 to G8, screen data a_{11} ... a_{mn}, and a plurality of large- and small-scale maps. The screen data represents lands, sea, rivers and so on displayed on the screen in different colors using the bit mapping technique.

Fig. 32 shows added geographical feature data stored in an IC card, which includes the comparison list data starting address shown in Fig. 32 (a), the geographical data comparison list shown in Fig. 32 (b), the modified data starting address shown in Fig. 32 (c), and the added geographical data shown in Fig. 32 (d). The IC card may also store the map of a parking lot or the like which cannot be stored in the CD. This allows for the reduction in the number of data stored in the CD.

Fig. 33 is a flowchart of processing of read of the geographical feature data. The contents of the processing are the same as those shown in Fig. 26, description thereof being omitted.

Fig. 34 is a flowchart of processing of search of the geographical feature data to be displayed. First, it is determined in step 281 whether or not it is the first time that the search is conducted. If it is, the geographical feature data which has a designated screen size and which contains the present position is searched (in steps 282 and 283). If it is determined that it is not the first time in step 281, it is determined in step 284 whether or not the screen size is to be changed. If the screen size is to be changed, it is determined in step 285 whether or not the screen is enlarged in step 285. If it is determined that the screen is scaled down, small-scale map data of a large area which contains the currently displayed screen is searched in step 286. If it is determined in step 285 that the screen is enlarged, it is determined in step 287 whether or not there are enlarged maps. If there are enlarged maps, the enlarged map of the portion in the area which contains the present position is searched in step 288. If there are no enlarged maps, the fact that there is no enlarged maps is informed to the driver in step 289. If the answer is negative in step 284, the processing goes to step 290 where it is determined whether or not the currently displayed screen contains the present position. If it does not, search is conducted on the latitude/longitude data for the adjacent screen which contains the present position in step 291. Thereafter, it is determined in step 292 whether or not there is the adjacent screen which contains the present position. If there is, the processing goes to step 283. If there is no such adjacent screen, the processing goes to step 286 where the small-scale map data is searched.

Fig. 35 is a flowchart of the processing of modification of the geographical feature data. This enables the roads, landmarks and names of places to be added on the screen and enables the present position on the display to be marked.

In the above-described embodiments, the present invention is applied to the coordinate origin method. It is to be noted, however, if the contents of the data are selected, the present invention can be applied to the fixed route method or the location method.

Fig. 36 is a flowchart of the navigation control conducted in the fixed route method. Once a user has input the present location and a destination, route search is executed (in steps 301 to 303). Once the route has been fixed, the present position and the route are displayed (in steps 304 and 305). Subsequently, the sensor signal which represents the vehicle position is input, and the present position is then calculated (in steps 306 and 307). The processing from steps 303 to 307 is repeated in step 308 to guide the vehicle to the destination.

Fig. 37 is a flowchart of the navigation control conducted in the location method. In this method, route search is not executed, and the map and the vehicle position are displayed on a screen. In consequence, only the geographical feature data is stored in a CD and an IC card.

Claims

1. A navigation system for a vehicle comprising:

a first external storage means (16) for storing first guidance data including road and intersection data;

a second storage means (17) for storing second guidance data; said guidance data being linked to said first guidance data;

output means (5,6) for outputting guidance information; and

CPU means (4) for receiving said first and second guidance data from said first and second storage means, supplementing said first guidance data by said second guidance data, and outputting said guidance information based on said supplemented guidance data via said output means, characterised in that said second guidance data contains supplementary road and intersection data relating to a geographic area forming part of a geographic area for which road and intersection data is stored in said first storage means and that said CPU means is programmed to select second guidance data when first guidance data overlap with second guidance data, to operate selectively upon said first and second guidance data stored in said first and second external storage means, and to present to said output means a displayed guidance route containing coordinated road and intersection data derived from both of said first and second storage means.

2. A navigation system according to Claim 1, characterised in that said second storage means (17) comprises a floppy disk, an optical disk, a magnetic tape, an IC card or an optical card.

3. A navigation system according to claim 1, characterised in that said CPU means (4) is programmed to prepare a comparison data list from said first and second guidance data stored in each of said first and second storage means, and to operate selectively upon said first and second guidance data stored in said first and second external storage means based on said comparison data list.

4. A navigation system according to Claim 1, characterised in that said second guidance data includes a comparison data list of said first and second guidance data, and said CPU means (4) is programmed to operate selectively upon said first and second guidance data stored in said first and second storage means based upon said comprison data list.

5. A navigation system according to Claim 1, characterised in that second guidance data includes a table for coordinating said first and second guidance data, and said CPU means (4) is programmed to operate selectively upon said first and second guidance data stored in said first and second storage means based upon said table.

6. A navigation system according to any one of Claims 1-5, characterised in that it includes receiving means (9,22) for inputting said second guidance data from an external source.

7. A navigation system according to Claim 6, characterised in that said receiving means includes a modem (22).

8. A navigation system according to any one of Claims 1-7, characterised in that said second storage means (17) is an external storage means including removable media containing said guidance data, and the arrangement is such that said second guidance data can be replaced by new second guidance data by replacing said removable media with a new removable media containing said new second guidance data.

9. A navigation ststem according to any one of Claims 1-8, characterised in that it further includes:

present position means (2) for determining a present position of said vehicle; and that

said CPU means (4) is further programmed to output said guidance information together with said present position via said output means.

10. A navigation system according to Claim 9, characterised in that said present position means comprises a GPS receiver (10).

11. A navigation system according to Claim 9, characterised in that said present position means comprises a beacon receiver (11).

12. A navigation system according to Claim 9, characterised in that said present position means comprises a geomagnetic sensor (12) and a distance sensor (13).

13. A navigation system according to Claim 9, characterised in that said present position means comprises a distance sensor (13) and a steering sensor (15).

14. A navigation system according to any one of Claims 9-13 characterised in that it further includes input means (7) for inputting a starting point and destination and that said CPU means (4) is further programmed to set a guide route based on said starting point and said destination by supplementing said first guidance data with said second guidance data when said destination is in said smaller geographic area, and to output said guide route as said guidance information together with said present position data via said output means.

15. A navigation system for a vehicle according to Claim 14, characterised in that said CPU means (4) is further programmed to set said guide route by setting coordinates of a plurality of points from said starting point to said destination and to output said guidance information based on said set coordinates via said output means (5,6) at each of said points up to said destination.

16. A navigation system for a vehicle according to any one of Claims 1-7 or 9-15, characterised in that said second storage means (20) is an internal storage means.

Patentansprüche

1. Navigationssystem für ein Fahrzeug mit:
einer ersten externen Speichereinrichtung (16) zum Speichern von ersten Leitdaten mit Straßen- und Kreuzungsdaten;
einer zweiten Speichereinrichtung (17) zum Speichern von zweiten Leitdaten,wobei diese Leitdaten mit den ersten Leitdaten verknüpft sind;
einer Ausgabeeinrichtung (5, 6) zum Ausgeben von Leitinformationen; und
einer CPU-Einrichtung (4) zum Empfangen der ersten und zweiten Leitdaten von der ersten und zweiten Speichereinrichtung, Ergänzen der ersten Leitdaten durch die zweiten Leitdaten und Ausgeben der Leitinformationen auf der Grundlage der ergänzten Leitdaten über die Ausgabeeinrichtung,
dadurch gekennzeichnet, daß die zweiten Leitdaten ergänzende Straßen- und Kreuzungsdaten für einen geographischen Bereich enthalten, der Teil eines geographischen Bereichs bildet, für den Straßen- und Kreuzungsdaten in der ersten Speichereinrichtung gespeichert sind, und daß die CPU-Einrichtung programmiert ist, zweite Leitdaten auszuwählen, wenn sich erste Leitdaten mit zweiten Leitdaten überlappen, um selektiv anhand der in der ersten und zweiten externen Speichereinrichtung gespeicherten ersten und zweiten Leitdaten zu arbeiten und um der Ausgabeeinrichtung eine angezeigte Leitroute anzubieten, die koordinierte Straßen- und Kreuzungsdaten enthält, die sowohl aus der ersten als auch zweiten Speichereinrichtung abgeleitet sind.

2. Navigationssystem nach Anspruch 1, dadurch gekennzeichnet, daß die zweite Speichereinrichtung (17) eine Diskette, eine optische Platte, ein Magnetband, eine IC-Karte oder eine optische Karte aufweist.

3. Navigationssystem nach Anspruch 1, dadurch gekennzeichnet, daß die CPU-Einrichtung (4) programmiert ist, eine vergleichsdatenliste aus den in der jeweiligen ersten und zweiten Speichereinrichtung gespeicherten ersten und zweiten Leitdaten zu erstellen und selektiv anhand der in der ersten und zweiten externen Speishereinrichtung gespeicherten ersten und zweiten Leitdaten auf der Grundlage der Vergleichsdatenliste zu arbeiten.

4. Navigationssystem nach Anspruch 1, dadurch gekennzeichnet, daß die zweiten Leitdaten eine Vergleichsdatenliste der ersten und zweiten Leitdaten aufweisen und die CPU-Einrichtung (4) programmiert ist, selektiv anhand der in dar ersten und zweiten Speichereinrichtung gespeicherten ersten und zweiten Leitdaten auf der Grundlage der Vergleichsdatenliste zu arbeiten.

5. Navigationssystem nach Anspruch 1, dadurch gekennzeichnet, daß die zweiten Leitdaten eine Tabelle zum Koordinieren der ersten und zweiten Leitdaten aufweisen und die CPU-Einrichtung (4) programmiert ist, selektiv anhand der in der ersten und zweiten Speichereinrichtung gespeicherten ersten und zweiten Leitdaten auf der Grundlage der Tabelle zu arbeiten.

6. Navigationssystem nach einem der Ansprüche 1 bis 5, dadurch gekennzeichnet, daß es eine Empfangseinrichtung (9, 22) zum Eingeben der zweiten Leitdaten von einer externen Quelle aufweist.

7. Navigationssystem nach Anspruch 6, dadurch gekennzeichnet, daß die Empfangseinrichtung ein Modem (22) aufweist.

8. Navigationssystem nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, daß die zweite Speichereinrichtung (17) eine externe Speichereinrichtung mit einem die Leitdaten enthaltenden entfernbaren Medium ist und die Anordnung so ist, daß die zweiten Leitdaten durch neue zweite Leitdaten ersetzt werden können, indem daß entfernbare Medium durch ein die neuen zweiten Leitdaten enthaltendes neues entfernbares Medium ersetzt wird.

9. Navigationssystem nach einem der Ansprüche 1 bis 8, dadurch gekennzeichnet, daß es ferner aufweist: eine Einrichtung (2) für die aktuelle Position zum Bestimmen einer aktuellen Position des Fahrzeugs; und daß die CPU-Einrichtung (4) ferner programmiert ist, die Leitinformationen zusammen mit der aktuellen Position

über die Ausgabeeinrichtung auszugeben.

10. Navigationssystem nach Anspruch 9, dadurch gekennzeichnet, daß die Einrichtung für die aktuelle Position einen GPS-Empfänger (10) aufweist.

11. Navigationssystem nach Anspruch 9, dadurch gekennzeichnet, daß die Einrichtung für die aktuelle Position einen Bakenempfänger (11) aufweist.

12. Navigationssysten nach Anspruch 9, dadurch gekennzeichnet, daß die Einrichtung für die aktuelle Position einen geomagnetischen Sensor (12) und einen Distanzsensor (13) aufweist.

13. Navigationssystem nach Anspruch 9, dadurch gekennzeichnet, daß die Einrichtung für die aktuelle Position einen Distanzsensor (13) und einen Lenksensor (15) aufweist.

14. Navigationssystem nach einem der Ansprüche 9 bis 13, dadurch gekennzeichnet, daß es ferner eine Eingabeeinrichtung (7) zum Eingaben eines Ausgangspunkts und eines Ziels aufweist und daß die CPU-Einrichtrnng (4) ferner programmiert ist, eine Leitroute auf der Grundlage des Ausgangspunkts und des Ziels durch Ergänzen der ersten Leitdaten durch die zweiten Leitdaten einzustellen, wenn das Ziel in dem kleineren geographischen Bereich liegt, und die Leitroute als die Leitinformationen zusammen mit der aktuellen Position über die Ausgabeeinrichtung auszugeben.

15. Navigationssystem für ein Fahrzeug noch Anspruch 14, dadurch gekennzeichnet, daß die CPU-Einrichtung (4) ferner programmiert ist, die Leitroute durch Einstellen von Koordinaten mehrerer Punkte von dem Ausgangspunkt zu dem Ziel einzustellen und die Leitinformationen auf der Grundlage der eingestellten Koordinaten über die Ausgabeeinrichtung (5, 6) an jedem der Punkte bis zu dem Ziel auszugeben.

16. Navigationssystem für ein Fahrzeug nach einem der Ansprüche 1 bis 7 oder 9 bis 15, dadurch gekennzeichnet, daß die zweite Speichereinrichtung (20) eine interne Speichereinrichtung ist.

Revendications

1. Système de navigation destiné à un véhicule, qui comprend

- un premier moyen de mémorisation externe (16) pour mémoriser des premières données de guidage incluant des données concernant les routes et les intersections,
- un second moyen de mémorisation (17) pour mémoriser des secondes données de guidage, lesdites données de guidage étant liées auxdites premières données de guidage,
- des moyens de sortie (5, 6) pour émettre en sortie une information de guidage, et
- une unité centrale ou CPU (4) pour recevoir lesdites premières et secondes données de guidage en provenance desdits premier et second moyens de mémorisation, pour compléter lesdites premières données de guidage avec lesdites secondes données de guidage et pour émettre en sortie, par l'intermédiaire desdits moyens de sortie, ladite information de guidage en se basant sur lesdites données de guidage complétées,

caractérisé en ce que lesdites secondes données de guidage contiennent des données complémentaires concernant les routes et les intersections relatives à une région géographique faisant partie d'une zone géographique pour laquelle des données concernant les routes et les intersections sont mémorisées dans ledit premier moyen de mémorisation,
et en ce que ladite unité centrale est programmée pour choisir les secondes données de guidage quand les premières données de guidage se chevauchent avec les secondes données de guidage, pour agir de façon sélective sur lesdites premières et secondes données de guidage mémorisées dans lesdits premier et second moyens de mémorisation et pour présenter auxdits moyens de sortie un trajet de guidage affiché qui contient des données coordonnées concernant les routes et les intersections déduites à la fois du premier et du second moyen de mémorisation.

2. Système de navigation selon la revendication 1, caractérisé en ce que ledit second moyen de mémorisation (17) est une disquette, un disque optique, une bande magnétique, une carte CI ou une carte optique.

3. Système de navigation selon la revendication 1, caractérisé en ce que ladite unité centrale (4) est programmée pour préparer une liste de données de comparaison à partir desdites premières et secondes données de guidage mémorisées dans chacun desdits premier et second moyens de mémorisation et pour agir de

façon sélective sur lesdites premières et secondes données de guidage mémorisées dans lesdits premier et second moyens de mémorisation en se basant sur ladite liste de données de comparaison.

4. Système de navigation selon la revendication 1, caractérisé en ce que lesdites secondes données de guidage incluent une liste de données de comparaison desdites premières et secondes données de guidage et ladite unité centrale (4) est programmée pour agir de façon sélective sur lesdites premières et secondes données de guidage mémorisées dans lesdits premier et second moyens de mémorisation en se basant sur ladite liste de données de comparaison.

5. Système de navigation selon la revendication 1, caractérisé en ce que lesdites secondes données de guidage incluent une table pour coordonner lesdites premières et secondes données de guidage, et ladite unité centrale (4) est programmée pour agir de façon sélective sur lesdites premières et secondes données de guidage mémorisées dans lesdits premier et second moyens de mémorisation en se basant sur ladite table.

6. Système de navigation selon l'une quelconque des revendications 1 à 5, caractérisé en ce qu'il comprend des moyens de réception (9, 22) pour entrer lesdites secondes données de guidage depuis une source extérieure.

7. Système de navigation selon la revendication 6, caractérisé en ce que lesdits moyens de réception comprennent un modem (22).

8. Système de navigation selon l'une quelconque des revendications 1 à 7, caractérisé en ce que ledit second moyen de mémorisation (17) est un moyen de mémorisation externe comprenant un support amovible qui contient lesdites données de guidage, et la disposition est telle que lesdites secondes données de guidage peuvent être remplacées par de nouvelles secondes données de guidage par remplacement dudit support mobile par un nouveau support mobile qui contient lesdites nouvelles secondes données de guidage.

9. Système de navigation selon l'une quelconque des revendications 1 à 8, caractérisé en ce qu'il comprend en outre un moyen (2) de définition de la position actuelle servant à déterminer la position actuelle dudit véhicule, et en ce que ladite unité centrale (4) est programmée en outre pour émettre ladite information de guidage en même temps que ladite position actuelle par l'intermédiaire dudit moyen de sortie.

10. Système de navigation selon la revendication 9, caractérisé en ce que ledit moyen de définition de la position actuelle comprend un récepteur GPS (10).

11. Système de navigation selon la revendication 9, caractérisé en ce que ledit moyen de définition de la position actuelle comprend un récepteur radioélectrique (11).

12. Système de navigation selon la revendication 9, caractérisé en ce que ledit moyen de définition de la position actuelle comprend un détecteur géomagnétique (12) et un détecteur de distance (13).

13. Système de navigation selon la revendication 9, caractérisé en ce que ledit moyen de définition de la position actuelle comprend un détecteur de distance (13) et un détecteur d'orientation (15).

14. Système de navigation selon l'une quelconque des revendications 9 à 13, caractérisé en ce qu'il comprend en outre un moyen d'entrée (7) pour entrer un point de départ et une destination et en ce que ladite unité centrale (4) est programmée en outre pour établir un trajet de guidage en se basant sur ledit point de départ et ladite destination et en complétant lesdites premières données de guidage par lesdites secondes données de guidage quand ladite destination se trouve dans ladite région géographique plus petite et pour émettre ledit trajet de guidage en tant que ladite information de guidage en même temps que ladite position actuelle par l'intermédiaire dudit moyen de sortie.

15. Système de navigation selon la revendication 14, caractérisé en ce que ladite unité centrale (4) est programmée en outre pour établir ledit trajet de guidage en définissant des coordonnées d'une pluralité de points entre ledit point de départ et ladite destination et pour émettre ladite information de guidage par l'intermédiaire desdits moyens de sortie (5, 6), en se basant sur lesdites coordonnées définies pour chacun desdits points jusqu'à ladite destination.

16. Système de navigation selon l'une quelconque des revendications 1 à 7 ou 9 à 15, caractérisé

en ce que ledit second moyen de mémorisation (20) est un moyen de mémorisation interne.

Fig.1 (a)

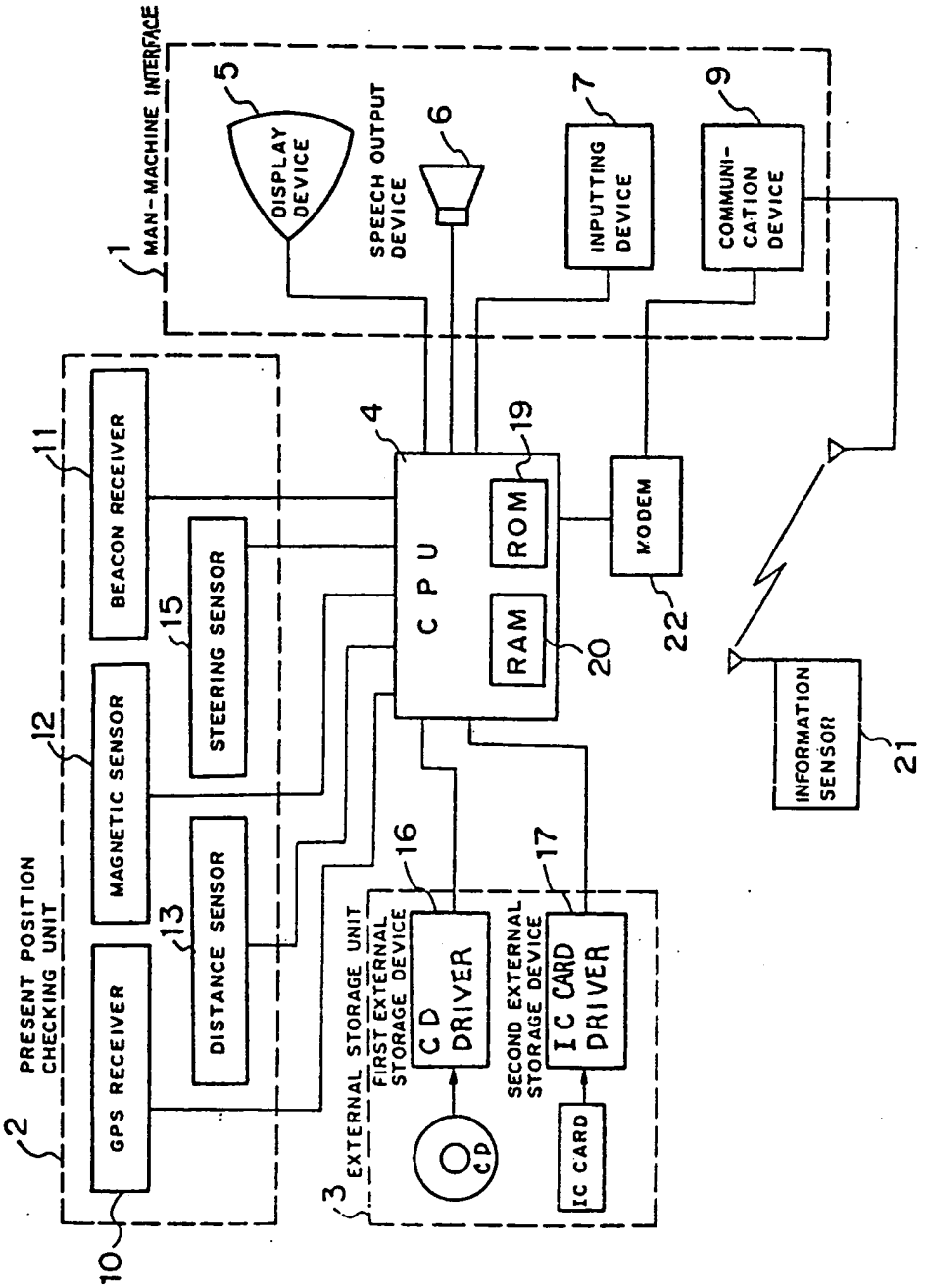

MAN-MACHINE INTERFACE
1
DISPLAY DEVICE
5
SPEECH OUTPUT DEVICE
6
INPUTTING DEVICE
7
COMMUNI-CATION DEVICE
9
PRESENT POSITION CHECKING UNIT
2
BEACON RECEIVER
11
MAGNETIC SENSOR
12
STEERING SENSOR
15
DISTANCE SENSOR
13
GPS RECEIVER
10
C P U
4
ROM
19
RAM
20
MODEM
22
INFORMATION SENSOR
21
EXTERNAL STORAGE UNIT
3
FIRST EXTERNAL STORAGE DEVICE
CD DRIVER
16
CD
SECOND EXTERNAL STORAGE DEVICE
IC CARD DRIVER
17
IC CARD

Fig.1 (b)

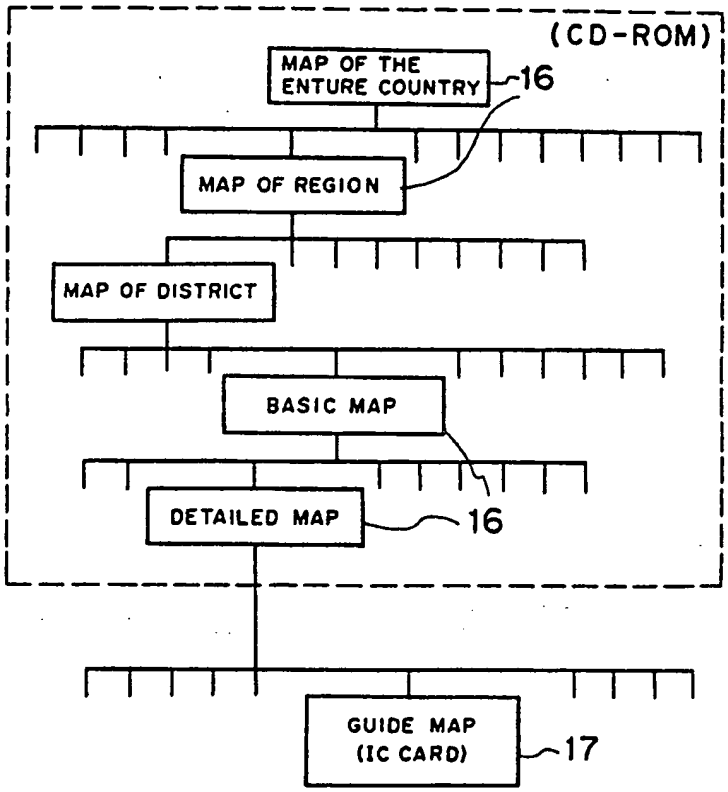

(CD-ROM)
MAP OF THE ENTURE COUNTRY
16
MAP OF REGION
MAP OF DISTRICT
BASIC MAP
DETAILED MAP
16
GUIDE MAP (IC CARD)
17

Fig.3(a)

LIST OF INTERSECTIONS

INTERSECTION NUMBER
1
2
3
27
36
56
⋮

Fig.3(b)

LIST OF LANDMARKS

LANDMARK NUMBER
1010
1011
1012
1536
1600
1609
⋮

Fig.3(c)

SORT FILE FOR ROMAN CHARACTER

NAME OF PREFECTURE (ROMAN CHARACTER)	ADDRESS OF DATA
AITIKEN	#F84#
⋮	⋮

Fig.3(d)

SORT FILE FOR HIRAGANA

NAME OF PREFECTURE	ADDRESS OF DATA
AITIKEN	#F84#
⋮	⋮

Fig.5

INTERSECTION DATA

INTERSECTION NUMBER	NAME OF INTERSECTION	LATITUDE	LONGITUDE	ROAD HAVING THE SMALLEST NUMBER AMONG THE ROADS WHICH START FROM THIS INTERSECTION	ROAD HAVING THE SMALLEST NUMBER AMONG THE ROADS WHICH ENDS AT THIS INTERSECTION	WITH OR WITHOUT SIGNAL
1	A A	+35.20	+137.00	1	2	WITH SIGNAL
2	A B	+35.20	+137.04	2	1	WITH SIGNAL
3	A C	+35.20	+137.09	4	3	WITH SIGNAL
4	A D	+35.20	+137.14	6	8	WITHOUT SIGNAL
5	B A	+35.17	+137.00	7	8	WITH SIGNAL
6	B B	+35.17	+137.04	12	9	WITH SIGNAL
7	B C	+35.17	+137.09	10	13	WITH SIGNAL
8	B D	+35.17	+137.14	16	15	WITHOUT SIGNAL
9	C A	+35.10	+137.00	17	18	WITH SIGNAL
10	C B	+35.10	+137.04	21	19	WITH SIGNAL
11	C C	+35.10	+137.03	23	22	WITH SIGNAL
12	C D	+35.10	+137.14	25	24	WITH SIGNAL
13	D A	+35.03	+137.00	26	27	WITH SIGNAL
14	D B	+35.03	+137.04	28	31	WITHOUT SIGNAL
15	D C	+35.03	+137.09	31	29	WITHOUT SIGNAL
16	D D	+35.03	+137.14	32	37	WITHOUT SIGNAL
17	E A	+35.00	+137.00	33	34	WITH SIGNAL
18	E B	+35.00	+137.04	35	33	WITH SIGNAL
19	E O	+35.00	+137.09	41	36	WITH SIGNAL
20	E D	+35.00	+137.14	37	42	WITH SIGNAL
21	F A	+35.05	+137.12	45	44	WITHOUT SIGNAL

Fig.6

LANDMARK DATA

LANDMARK NUMBER	NAME OF LANDMARK	LATITUDE	LONGITUDE	CLOSEST INTERSECTION NUMBER 1	CLOSEST INTERSECTION NUMBER 2
1	A A A	+35.183	+137.077	6	7
2	A A B	+35.120	+137.005	5	9
3	A A C	+35.103	+137.127	11	12
4	A A D	+35.073	+137.045	14	10
5	A A E	+35.025	+137.222	14	13
6	A A F	+35.095	+137.058	11	10

Fig.7

ROAD DATA

ROAD NUMBER	STARTING POINT	ENDING POINT	ONE OF THE ROADS WHICH START FROM THE SAME STARTING POINT	ONE OF THE ROADS WHICH END AT THE SAME ENDING POINT	WIDTH OF ROAD	NO RIGHT-TURN	NO LEFT-TURN	NOT GUIDED	PHOTO NUMBER
1	1	2	8	4	1	0	0	3	1
2	2	1	3	7	1	0	0	0	2
17	9	5	20	8	2	0	0	7	17
18	5	9	7	21	2	0	0	27	18
19	6	10	12	20	0	0	0	0	19
20	9	10	27	23	2	28	19	22	20
21	10	9	22	26	2	0	0	0	21
22	10	11	21	25	2	0	0	24	22
23	11	10	24	28	2	19	28	21	23
24	11	12	29	45	2	45	0	0	24
25	12	11	0	22	2	0	0	23	25
26	13	9	34	18	2	0	0	17	26
27	9	13	17	30	2	0	30	34	27
28	14	10	30	19	0	0	0	0	28
29	11	15	23	32	0	0	32	36	29
30	14	13	26	33	0	0	0	0	30
42	19	20	41	0	1	0	0	0	42
43	20	19	37	36	1	36	0	41	43
44	15	21	31	0	0	0	0	45	44
45	21	12	46	24	0	0	0	0	45
46	21	16	45	37	0	0	0	0	46

Fig.8

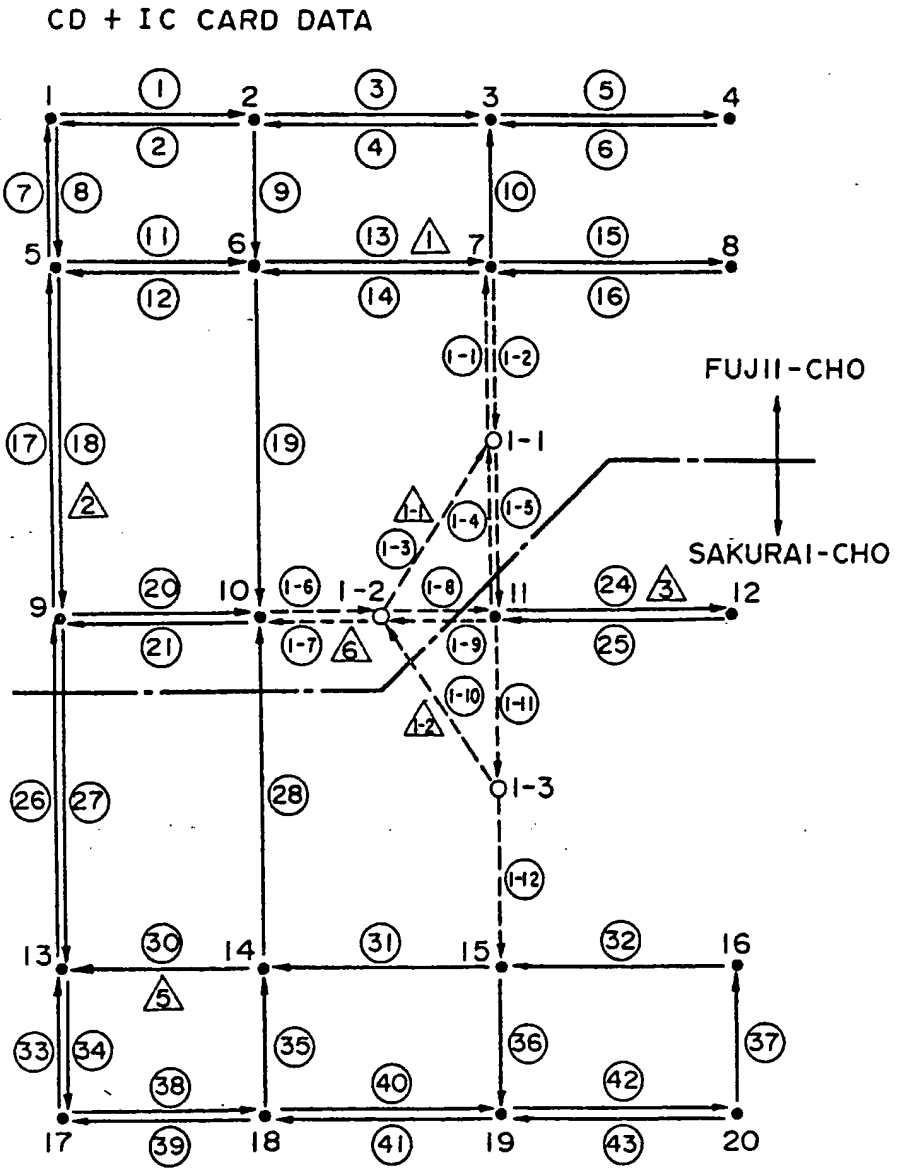


Fig. 9

INTERSECTION DATA (DATA ADDED)

INTERSECTION NUMBER	NAME OF INTERSECTION	LATITUDE	LONGITUDE	ROAD HAVING THE SMALLEST NUMBER AMONG THE ROADS WHICH START FROM THIS INTERSECTION	ROAD HAVING THE SMALLEST NUMBER AMONG THE ROADS WHICH END AT THIS INTERSECTION	WITH OR WITHOUT SIGNAL
1-1	X A	+35.135	+137.09	1 - 1	1 - 2	WITH SIGNAL
1 - 2	X B	+35.10	+137.085	1 - 9	1 - 8	WITH SIGNAL
1 - 3	X C	+35.085	+137.09	1 - 10	1 - 11	WITHOUT SIGNAL
11	C C	+35.03	+137.09	24	25	WITH SIGNAL
15	D C	+35.03	+137.09	31	32	WITHOUT SIGNAL

Fig. 10

LANDMARK DATA (DATA ADDED)

LANDMARK NUMBER	NAME OF LANDMARK	LATITUDE	LONGITUDE	CLOSEST INTERSECTION NUMBER 1	CLOSEST INTERSECTION NUMBER 2
1 - 1	X X A	+35.122	+137.082	1 - 2	1 - 1
1 - 2	X X B	+35.078	+137.083	1 - 3	1 - 2
8	A A F	+35.095	+137.058	1 - 2	10

Fig.11

ROAD DATA (DATA ADDED)

ROAD NUMBER	STARTING POINT	ENDING POINT	ONE OF THE ROADS WHICH START FROM THE SAME STARTING POINT	ONE OF THE ROADS WHICH END AT THE SAME ENDING POINT	WIDTH OF ROAD	NO RIGHT-TURN	NO LEFT-TURN	NOT GUIDED	PHOTO NUMBER
1-1	1-1	7	1-5	13	1	0	0	10	1-1
1-2	7	1-1	10	1-3	1	0	0	1-5	1-2
1-3	1-2	1-1	1-7	1-4	0	0	0	0	1-3
1-4	11	1-1	1-9	1-2	1	0	1-3	1-1	1-4
1-5	1-1	11	1-1	1-8	1	0	0	1-11	1-5
1-6	10	1-2	21	1-9	2	0	1-10	1-8	1-6
1-7	1-2	10	1-8	19	2	19	28	21	1-7
1-8	1-2	11	1-3	25	2	0	0	24	1-8
1-9	11	1-2	1-11	1-10	2	0	1-10	1-7	1-9
1-10	1-3	1-2	1-12	1-6	0	0	0	1-3	1-10
1-11	11	1-3	24	0	0	0	0	1-12	1-11
1-12	1-3	15	1-10	32	0	0	32	36	1-12
15	7	8	1-2	0	1	0	0	0	15
16	8	7	0	1-1	1	0	0	14	1-12
20	9	10	27	28	2	28	19	1-6	20
21	10	9	1-6	26	2	0	0	0	21
24	11	12	1-4	0	2	0	0	0	24
25	12	11	0	1-5	2	0	0	1-9	1-14
28	14	10	30	1-7	0	0	0	0	28
32	16	15	0	1-12	0	1-12	0	31	32
36	15	19	31	40	0	0	0	0	36
37	20	16	43	0	0	0	0	0	1-15

Fig.12(a)

DATA ON THE LIST OF SUB-DISTRICTS TO BE CHANGED

FUJIITYO	NAME OF SUB-DISTRICT (CHINESE CHARACTER)
FUJIITYO	NAME OF SUB-DISTRICT (HIRAGANA)
FUJIITYO	NAME OF SUB-DISTRICT (ROMAN CHARACTER)
01-01-01	PREFECTURE NUMBER-CITY NUMBER-SUB-DISTRICT NUMBER
010000	ADDRESS OF LIST OF INTERSECTIONS
12	NUMBER OF INTERSECTIONS IN THE LIST OF INTERSECTIONS
01C000	ADDRESS OF LIST OF LANDMARKS
4	NUMBER OF LANDMARKS IN THE LIST OF LANDMARKS
193	MAJOR INTERSECTION/ LANDMARK NUMBER

Fig.12(b)

LIST OF INTERSECTIONS

INTERSECTION NUMBER
1-1
1-2
1
2
3
4
1-3
11
12
13
14
15

Fig.12(c)

LIST OF LANDMARKS

LANDMARK NUMBER
1-1
1
2
6
1-2
5

Fig.13(a)

LIST OF ROADS DELETED

ROAD NUMBER
22
23
29
44
45
46
47

Fig.13(b)

LIST OF INTERSECTIONS DELETED

INTERSECTION NUMBER
21

Fig.13(c)

LIST OF LANDMRKS

LANDMARK NUMBER
4

Fig.13(d)

STARTING ADDRESS OF LIST OF DELETION

NAME OF DATA	ADDRESS
LIST OF PREFECTURES	000000
LIST OF CITIES	000000
LIST OF SUB-DISTRICTS	000000
ROAD DATA	000100
INTERSECTION DATA	000500
LANDMARK DATA	000800

Fig.13(e)

STARTING ADDRESS OF DATA CHANGED

NAME OF DATA	ADDRESS
LIST OF PREFECTURES	000000
LIST OF CITIES	000000
LIST OF SUB-DISTRICTS	000A00
ROAD DATA	010A00
INTERSECTION DATA	03A000
LANDMARK DATA	04A000

Fig.15(a)

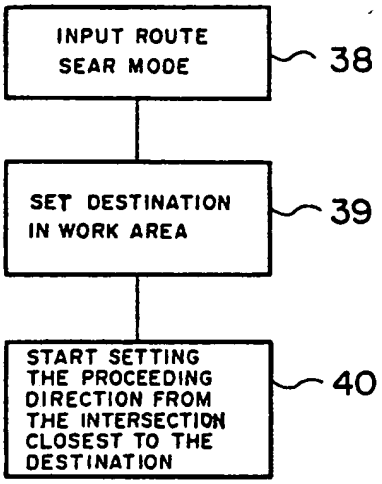


Fig.15(b)

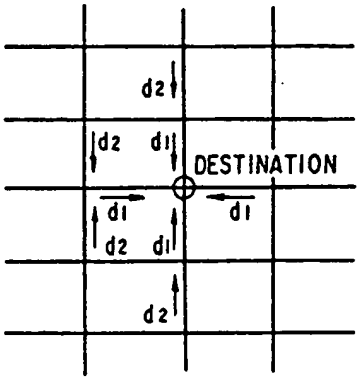


Fig.16

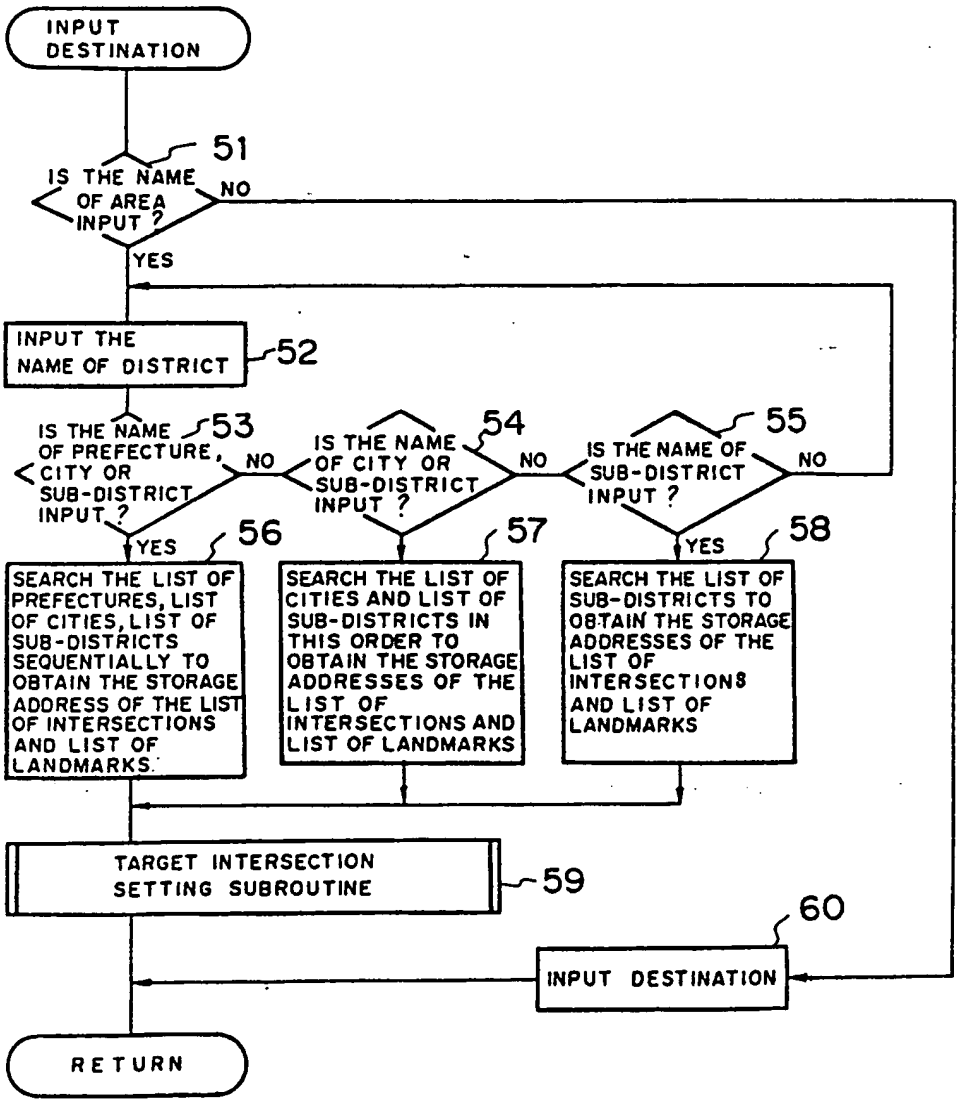

INPUT DESTINATION
51
IS THE NAME OF AREA INPUT ?
NO
YES
INPUT THE NAME OF DISTRICT
52
IS THE NAME OF PREFECTURE, CITY OR SUB-DISTRICT INPUT ?
53
NO
YES
IS THE NAME OF CITY OR SUB-DISTRICT INPUT ?
54
NO
IS THE NAME OF SUB-DISTRICT INPUT ?
55
NO
YES
56
SEARCH THE LIST OF PREFECTURES, LIST OF CITIES, LIST OF SUB-DISTRICTS SEQUENTIALLY TO OBTAIN THE STORAGE ADDRESS OF THE LIST OF INTERSECTIONS AND LIST OF LANDMARKS.
57
SEARCH THE LIST OF CITIES AND LIST OF SUB-DISTRICTS IN THIS ORDER TO OBTAIN THE STORAGE ADDRESSES OF THE LIST OF INTERSECTIONS AND LIST OF LANDMARKS
58
SEARCH THE LIST OF SUB-DISTRICTS TO OBTAIN THE STORAGE ADDRESSES OF THE LIST OF INTERSECTIONS AND LIST OF LANDMARKS
TARGET INTERSECTION SETTING SUBROUTINE
59
60
INPUT DESTINATION
RETURN

Fig.17

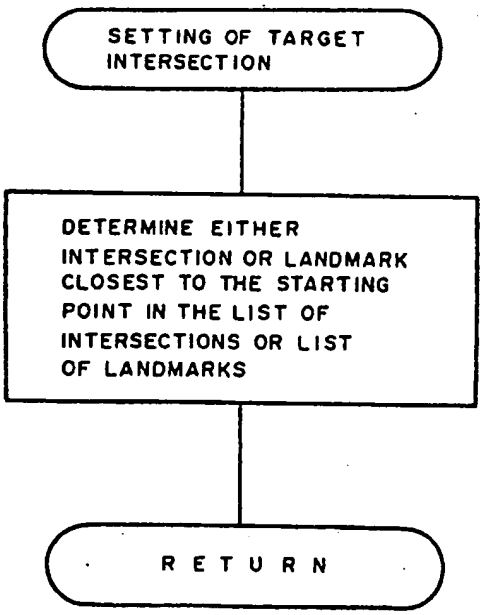

SETTING OF TARGET INTERSECTION
DETERMINE EITHER INTERSECTION OR LANDMARK CLOSEST TO THE STARTING POINT IN THE LIST OF INTERSECTIONS OR LIST OF LANDMARKS
RETURN

Fig.18

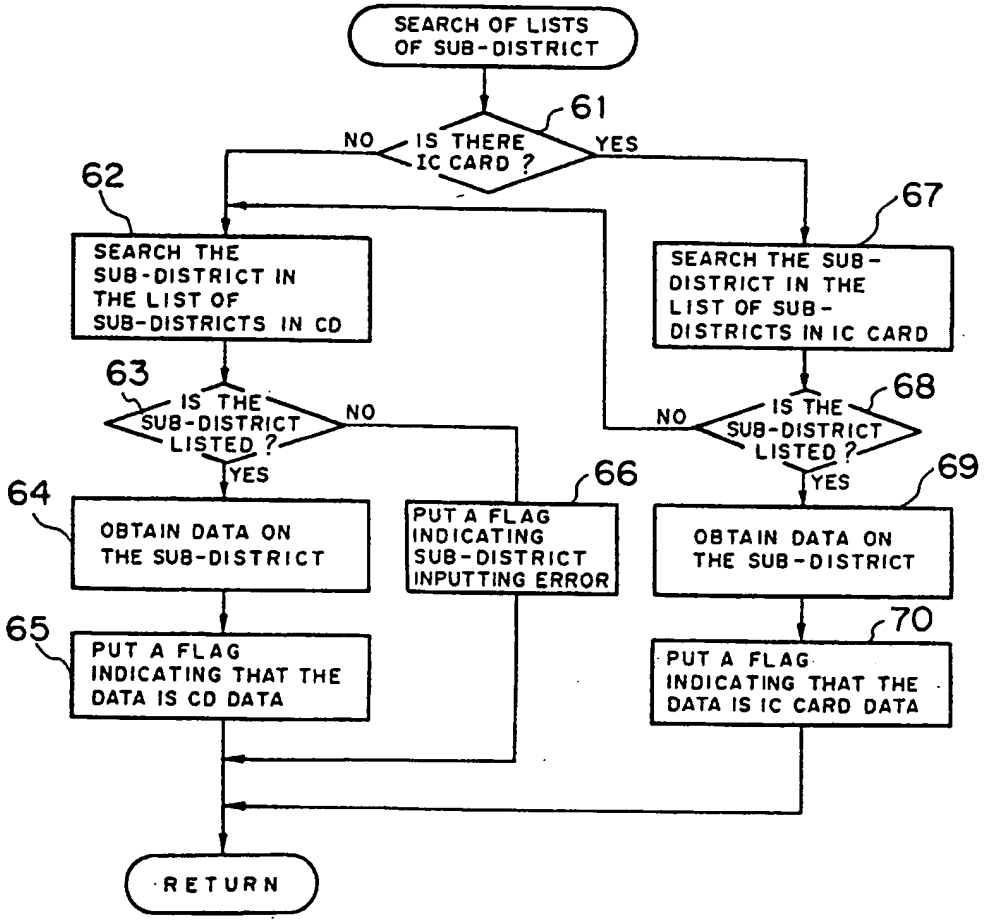

SEARCH OF LISTS OF SUB-DISTRICT
61
IS THERE IC CARD ?
NO
YES
62
SEARCH THE SUB-DISTRICT IN THE LIST OF SUB-DISTRICTS IN CD
63
IS THE SUB-DISTRICT LISTED ?
NO
YES
64
OBTAIN DATA ON THE SUB-DISTRICT
65
PUT A FLAG INDICATING THAT THE DATA IS CD DATA
66
PUT A FLAG INDICATING SUB-DISTRICT INPUTTING ERROR
67
SEARCH THE SUB-DISTRICT IN THE LIST OF SUB-DISTRICTS IN IC CARD
68
IS THE SUB-DISTRICT LISTED ?
NO
YES
69
OBTAIN DATA ON THE SUB-DISTRICT
70
PUT A FLAG INDICATING THAT THE DATA IS IC CARD DATA
RETURN

Fig.19

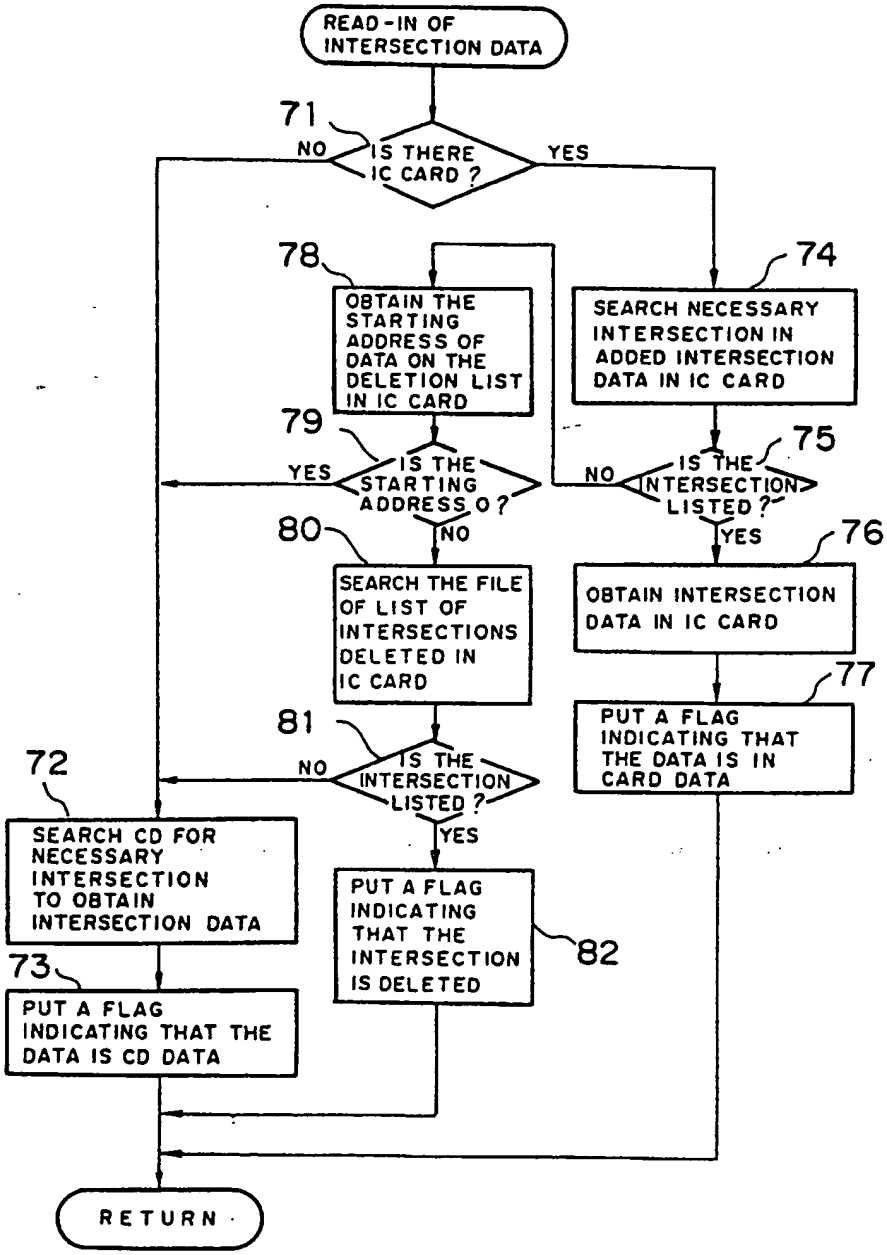

READ-IN OF INTERSECTION DATA
71
IS THERE IC CARD ?
NO
YES
78
OBTAIN THE STARTING ADDRESS OF DATA ON THE DELETION LIST IN IC CARD
74
SEARCH NECESSARY INTERSECTION IN ADDED INTERSECTION DATA IN IC CARD
79
IS THE STARTING ADDRESS 0 ?
YES
NO
75
IS THE INTERSECTION LISTED ?
NO
YES
80
SEARCH THE FILE OF LIST OF INTERSECTIONS DELETED IN IC CARD
76
OBTAIN INTERSECTION DATA IN IC CARD
77
PUT A FLAG INDICATING THAT THE DATA IS IN CARD DATA
81
IS THE INTERSECTION LISTED ?
NO
YES
72
SEARCH CD FOR NECESSARY INTERSECTION TO OBTAIN INTERSECTION DATA
PUT A FLAG INDICATING THAT THE INTERSECTION IS DELETED
82
73
PUT A FLAG INDICATING THAT THE DATA IS CD DATA
RETURN

Fig.20

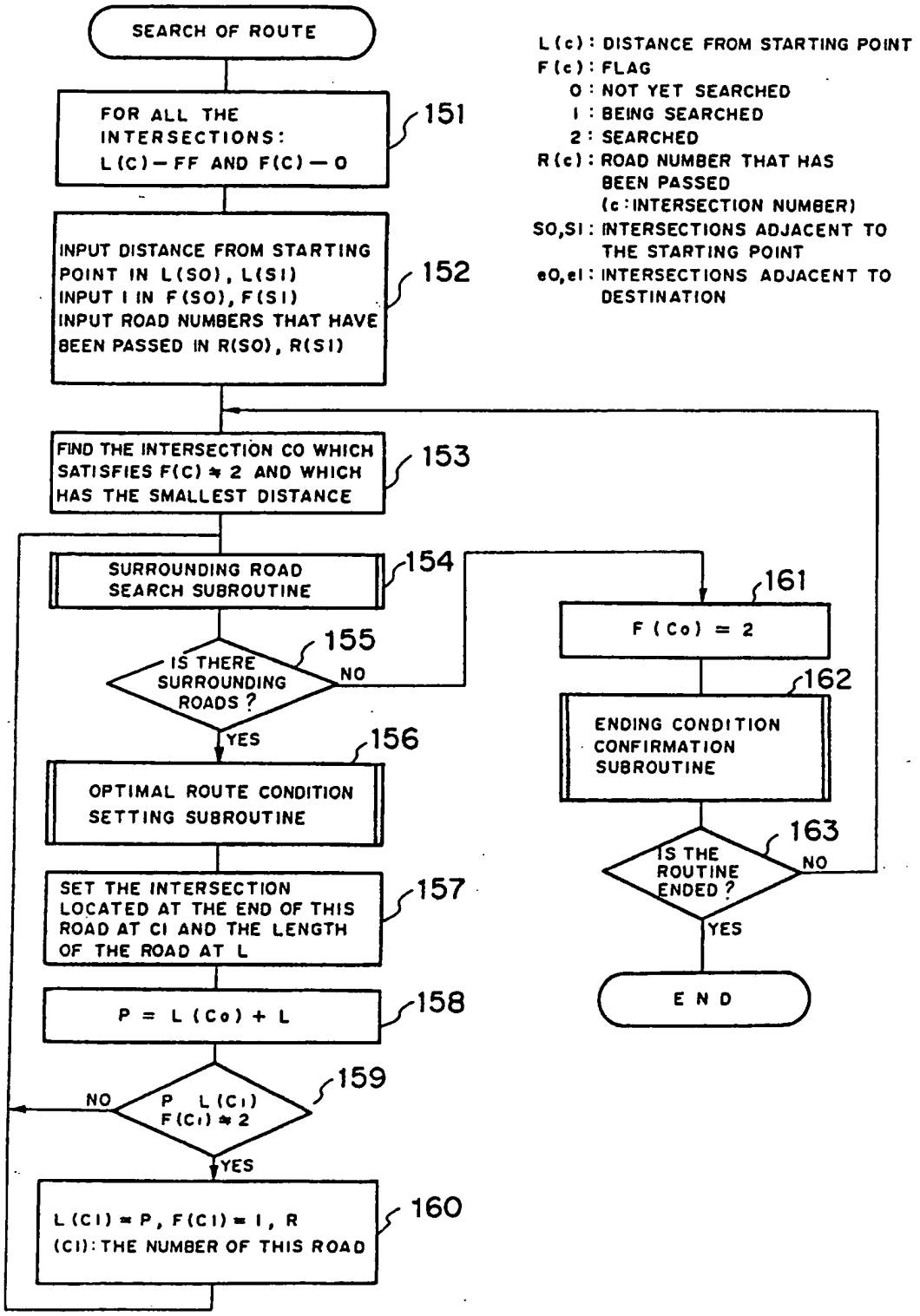

SEARCH OF ROUTE
FOR ALL THE INTERSECTIONS: L(C) — FF AND F(C) — 0
151
INPUT DISTANCE FROM STARTING POINT IN L(SO), L(S1)
INPUT 1 IN F(SO), F(S1)
INPUT ROAD NUMBERS THAT HAVE BEEN PASSED IN R(SO), R(S1)
152
FIND THE INTERSECTION CO WHICH SATISFIES F(C) ≠ 2 AND WHICH HAS THE SMALLEST DISTANCE
153
SURROUNDING ROAD SEARCH SUBROUTINE
154
IS THERE SURROUNDING ROADS ?
155
NO
YES
OPTIMAL ROUTE CONDITION SETTING SUBROUTINE
156
SET THE INTERSECTION LOCATED AT THE END OF THIS ROAD AT CI AND THE LENGTH OF THE ROAD AT L
157
P = L(Co) + L
158
P L(C1) F(C1) ≠ 2
159
NO
YES
L(C1) = P, F(C1) = 1, R(C1): THE NUMBER OF THIS ROAD
160
F(Co) = 2
161
ENDING CONDITION CONFIRMATION SUBROUTINE
162
IS THE ROUTINE ENDED ?
163
NO
YES
E N D
L(c): DISTANCE FROM STARTING POINT
F(c): FLAG
0: NOT YET SEARCHED
1: BEING SEARCHED
2: SEARCHED
R(c): ROAD NUMBER THAT HAS BEEN PASSED (c: INTERSECTION NUMBER)
SO,S1: INTERSECTIONS ADJACENT TO THE STARTING POINT
eO,e1: INTERSECTIONS ADJACENT TO DESTINATION

Fig.21

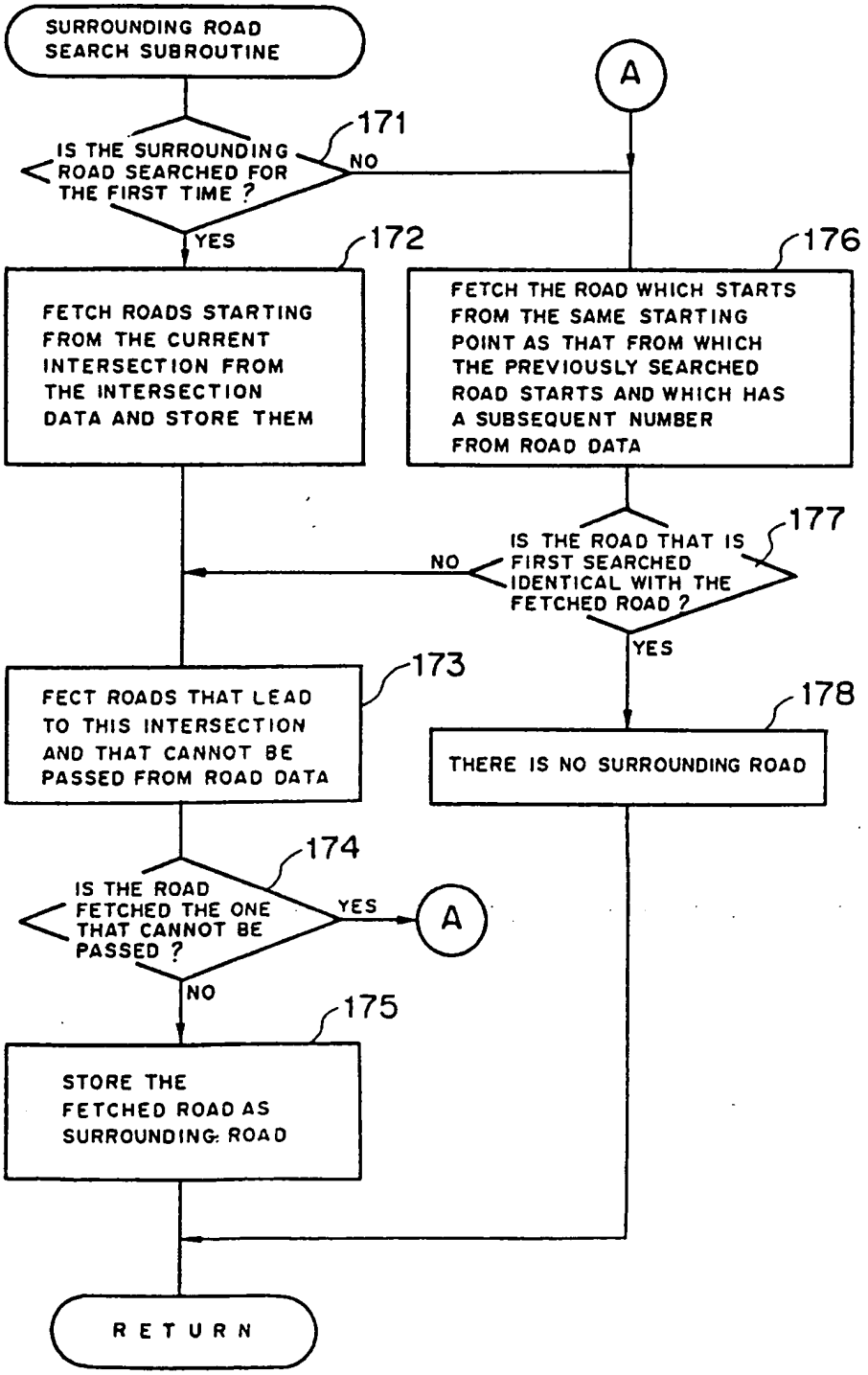

SURROUNDING ROAD SEARCH SUBROUTINE
A
171
IS THE SURROUNDING ROAD SEARCHED FOR THE FIRST TIME ?
NO
YES
172
FETCH ROADS STARTING FROM THE CURRENT INTERSECTION FROM THE INTERSECTION DATA AND STORE THEM
176
FETCH THE ROAD WHICH STARTS FROM THE SAME STARTING POINT AS THAT FROM WHICH THE PREVIOUSLY SEARCHED ROAD STARTS AND WHICH HAS A SUBSEQUENT NUMBER FROM ROAD DATA
177
IS THE ROAD THAT IS FIRST SEARCHED IDENTICAL WITH THE FETCHED ROAD ?
NO
YES
173
FECT ROADS THAT LEAD TO THIS INTERSECTION AND THAT CANNOT BE PASSED FROM ROAD DATA
178
THERE IS NO SURROUNDING ROAD
174
IS THE ROAD FETCHED THE ONE THAT CANNOT BE PASSED ?
YES
A
NO
175
STORE THE FETCHED ROAD AS SURROUNDING ROAD
RETURN

Fig.22

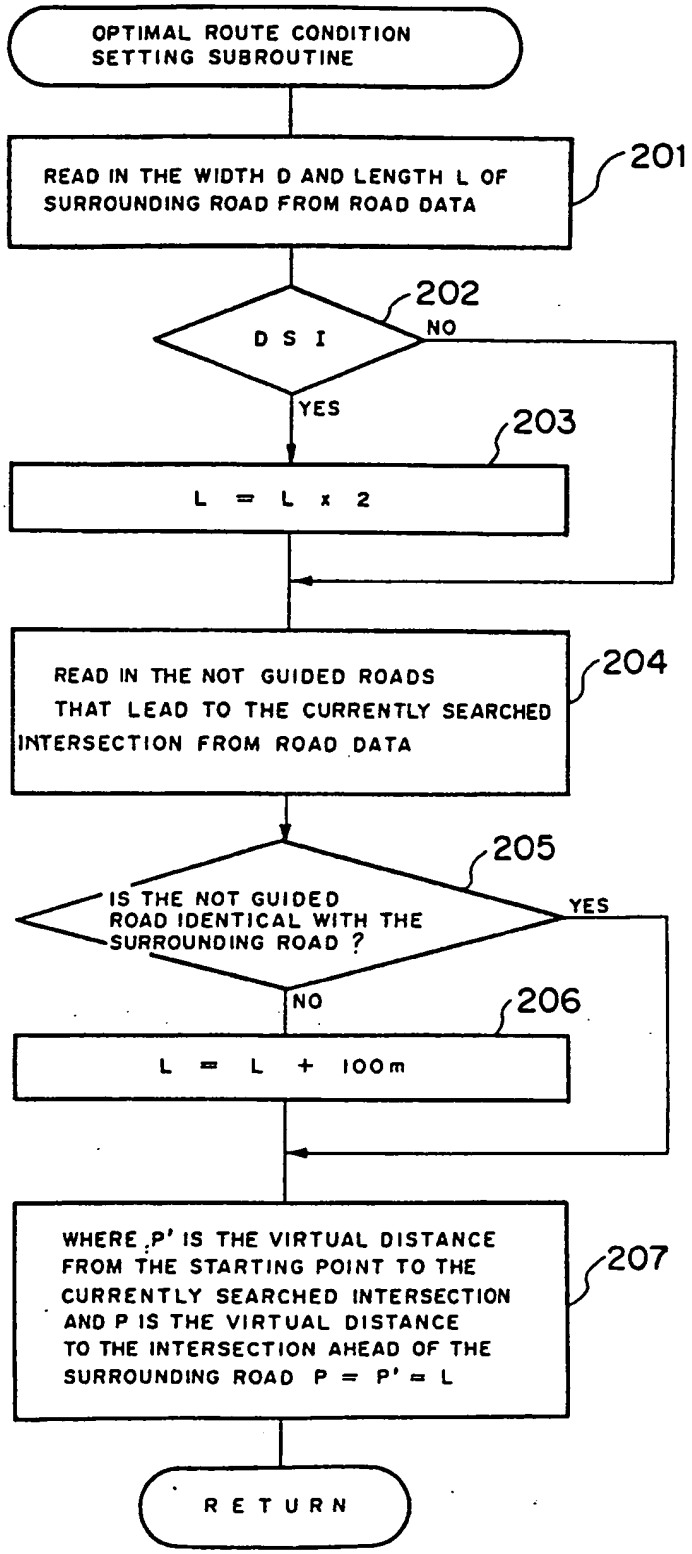

OPTIMAL ROUTE CONDITION SETTING SUBROUTINE
READ IN THE WIDTH D AND LENGTH L OF SURROUNDING ROAD FROM ROAD DATA
201
D S I
202
NO
YES
L = L x 2
203
READ IN THE NOT GUIDED ROADS THAT LEAD TO THE CURRENTLY SEARCHED INTERSECTION FROM ROAD DATA
204
IS THE NOT GUIDED ROAD IDENTICAL WITH THE SURROUNDING ROAD ?
205
YES
NO
L = L + 100m
206
WHERE P' IS THE VIRTUAL DISTANCE FROM THE STARTING POINT TO THE CURRENTLY SEARCHED INTERSECTION AND P IS THE VIRTUAL DISTANCE TO THE INTERSECTION AHEAD OF THE SURROUNDING ROAD P = P' = L
207
RETURN

Fig.23(a)

STARTING ADDRESS OF COMPARISON DATA

NAME OF DATA	ADDRESS
LIST OF PREFECTURES	000000
LIST OF CITIES	000000
LIST OF SUB-DISTRICTS	000100
ROAD DATA	001000
INTERSECTION DATA	00A000
LANDMARK DATA	00F000

Fig.23(b)

COMPARISON LIST OF SUB-DISTRICTS

SUB-DISTRICT NUMBER	SEQUENCE OF DATA ON CHANGE
01 - 01 - 01	1
01 - 01 - 02	2
01 - 01 - 03	0
01 - 01 - 04	0
⋮	⋮

Fig.23(c)

COMPARISON LIST OF ROAD DATA

ROAD NUMBER	SEQUENCE OF DATA ON CHANGE
1	0
2	0
⋮	⋮
17	0
18	0
19	0
20	3
21	4
22	-1
23	-1
24	5
25	6
26	0
27	0
28	7
29	-1
⋮	⋮
42	0
43	-1
44	-1
45	-1
46	-1

Fig.24(a)

COMPARISON LIST OF INTERSECTION DATA

INTERSECTION NUMBER	SEQUENCE OF DATA ON CHANGE
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	1
12	0
13	0
14	0
15	2
16	0
17	0
18	0
19	0
20	0
21	-1

Fig.24(b)

COMPARISON LIST OF LANDMARK DATA

LANDMARK NUMBER	SEQUENCE OF DATA ON CHANGE
1	0
2	0
3	0
4	-1
5	0
6	1

Fig.24(c)

STARTING ADDRESS OF DATA ON CHANGE

NAME OF DATA	ADDRESS
LIST OF SUB-DISTRICTS	020000
ROAD DATA	021000
INTERSECTION DATA	040000
LANDMARK DATA	04C000

Fig. 25

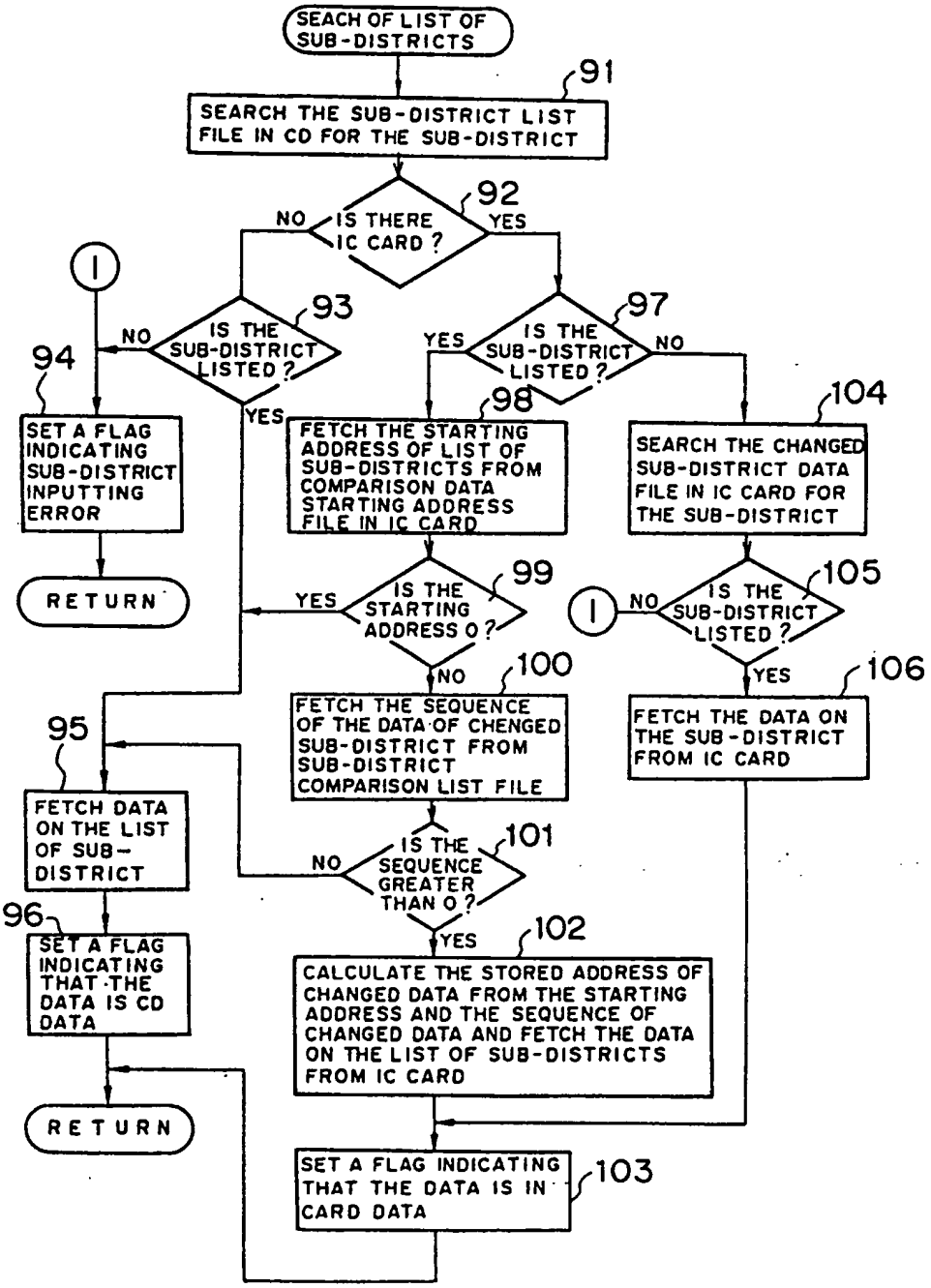

SEACH OF LIST OF SUB-DISTRICTS
91
SEARCH THE SUB-DISTRICT LIST FILE IN CD FOR THE SUB-DISTRICT
92
IS THERE IC CARD ?
NO
YES
1
93
IS THE SUB-DISTRICT LISTED ?
NO
YES
94
SET A FLAG INDICATING SUB-DISTRICT INPUTTING ERROR
RETURN
97
IS THE SUB-DISTRICT LISTED ?
YES
NO
98
FETCH THE STARTING ADDRESS OF LIST OF SUB-DISTRICTS FROM COMPARISON DATA STARTING ADDRESS FILE IN IC CARD
99
IS THE STARTING ADDRESS 0 ?
YES
NO
100
FETCH THE SEQUENCE OF THE DATA OF CHENGED SUB-DISTRICT FROM SUB-DISTRICT COMPARISON LIST FILE
101
IS THE SEQUENCE GREATER THAN 0 ?
NO
YES
102
CALCULATE THE STORED ADDRESS OF CHANGED DATA FROM THE STARTING ADDRESS AND THE SEQUENCE OF CHANGED DATA AND FETCH THE DATA ON THE LIST OF SUB-DISTRICTS FROM IC CARD
104
SEARCH THE CHANGED SUB-DISTRICT DATA FILE IN IC CARD FOR THE SUB-DISTRICT
105
1
IS THE SUB-DISTRICT LISTED ?
NO
YES
106
FETCH THE DATA ON THE SUB-DISTRICT FROM IC CARD
95
FETCH DATA ON THE LIST OF SUB-DISTRICT
96
SET A FLAG INDICATING THAT THE DATA IS CD DATA
RETURN
SET A FLAG INDICATING THAT THE DATA IS IN CARD DATA
103

Fig.26

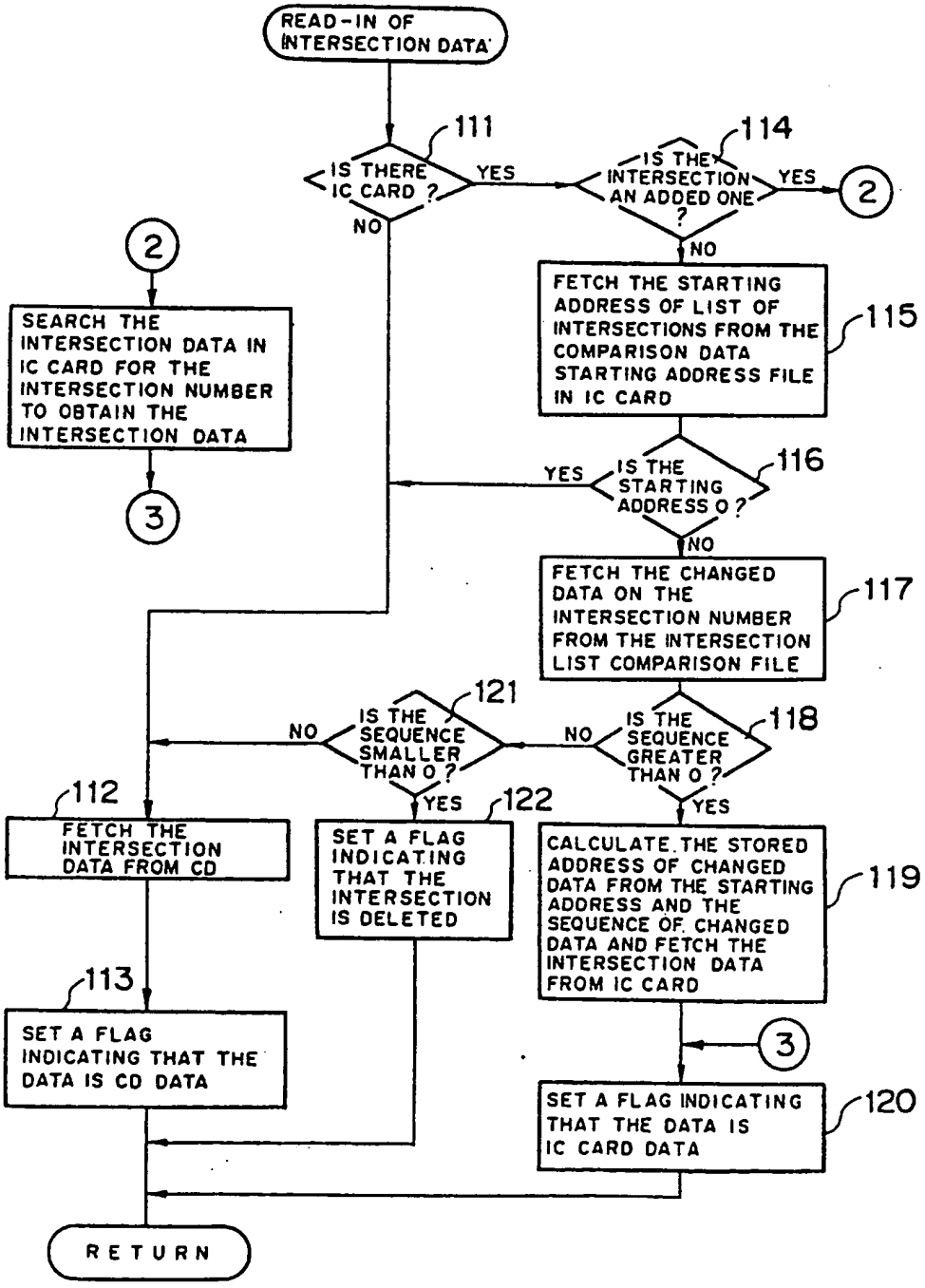

READ-IN OF INTERSECTION DATA
111
IS THERE IC CARD ?
YES
NO
114
IS THE INTERSECTION AN ADDED ONE ?
YES
2
NO
2
SEARCH THE INTERSECTION DATA IN IC CARD FOR THE INTERSECTION NUMBER TO OBTAIN THE INTERSECTION DATA
3
FETCH THE STARTING ADDRESS OF LIST OF INTERSECTIONS FROM THE COMPARISON DATA STARTING ADDRESS FILE IN IC CARD
115
YES
IS THE STARTING ADDRESS 0 ?
116
NO
FETCH THE CHANGED DATA ON THE INTERSECTION NUMBER FROM THE INTERSECTION LIST COMPARISON FILE
117
121
NO
IS THE SEQUENCE SMALLER THAN 0 ?
NO
IS THE SEQUENCE GREATER THAN 0 ?
118
112
FETCH THE INTERSECTION DATA FROM CD
YES
122
SET A FLAG INDICATING THAT THE INTERSECTION IS DELETED
YES
CALCULATE THE STORED ADDRESS OF CHANGED DATA FROM THE STARTING ADDRESS AND THE SEQUENCE OF CHANGED DATA AND FETCH THE INTERSECTION DATA FROM IC CARD
119
113
SET A FLAG INDICATING THAT THE DATA IS CD DATA
3
SET A FLAG INDICATING THAT THE DATA IS IC CARD DATA
120
RETURN

Fig.27 (a)

THE HIGHEST LATITUDE	+ 35.17
THE LOWEST LATITUDE	+ 35.03
THE HIGHEST LONGITUDE	+137.14
THE LOWEST LONGITUDE	+137.04

Fig.27(b)

NUMBER	LATITUDE	LONGITUDE
1	+35.03	+137.14
2	+35.03	+137.04
3	+35.17	+137.04
4	+35.17	+137.14

Fig.27(c)

NUMBER	ROAD NUMBER
1	32
2	31
3	28
4	19
5	14
6	16

Fig.27(d)

NUMBER	INTERSECTION/LANDMARK NUMBER
1	K - 16
2	K - 14
3	K - 6
4	K - 8

K : INTERSECTION
T : LANDMARK

Fig.28

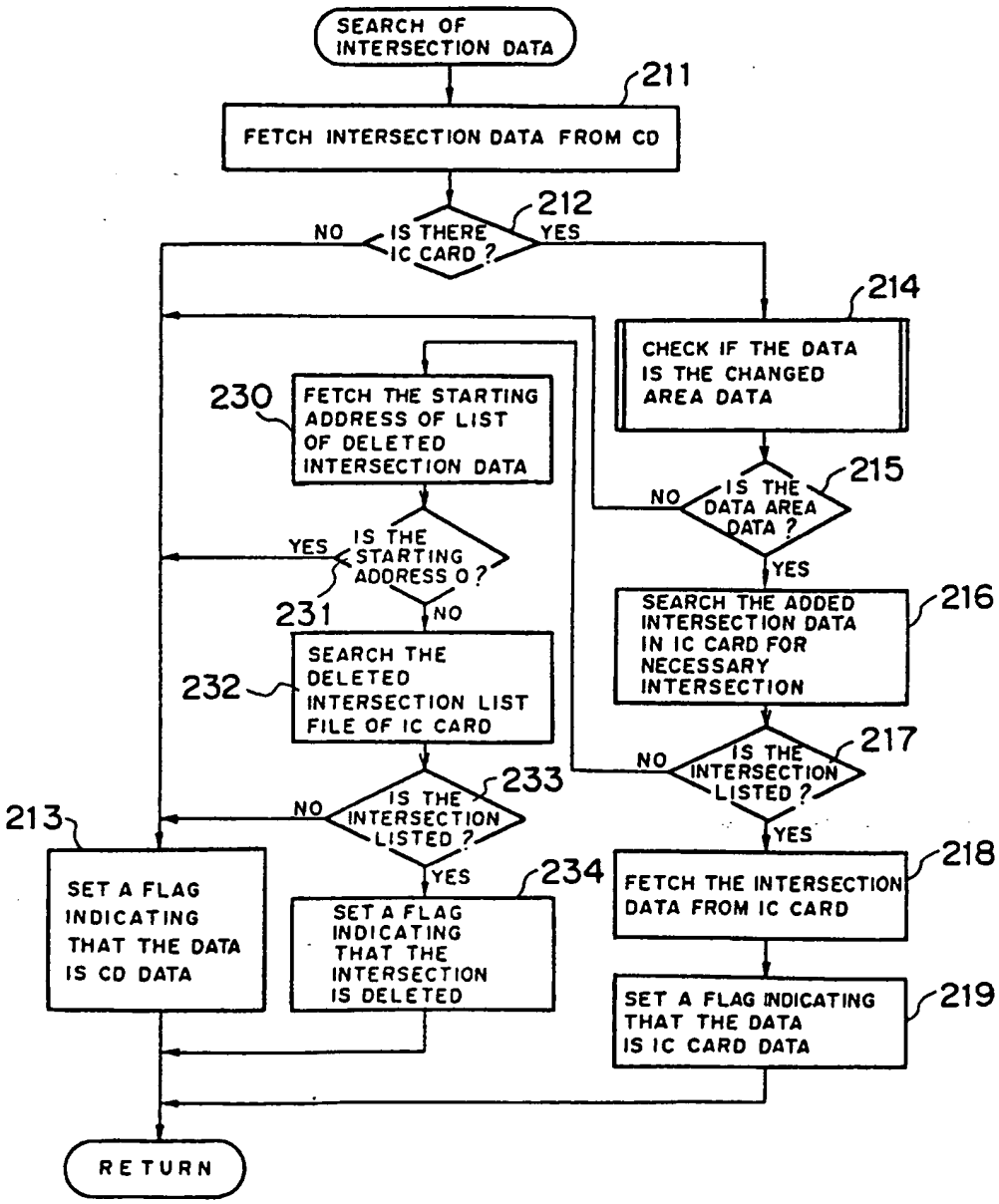

SEARCH OF INTERSECTION DATA
211
FETCH INTERSECTION DATA FROM CD
212
NO
IS THERE IC CARD ?
YES
214
CHECK IF THE DATA IS THE CHANGED AREA DATA
230
FETCH THE STARTING ADDRESS OF LIST OF DELETED INTERSECTION DATA
215
NO
IS THE DATA AREA DATA ?
YES
YES
IS THE STARTING ADDRESS 0 ?
231
NO
216
SEARCH THE ADDED INTERSECTION DATA IN IC CARD FOR NECESSARY INTERSECTION
232
SEARCH THE DELETED INTERSECTION LIST FILE OF IC CARD
217
NO
IS THE INTERSECTION LISTED ?
YES
233
213
NO
IS THE INTERSECTION LISTED ?
YES
218
FETCH THE INTERSECTION DATA FROM IC CARD
234
SET A FLAG INDICATING THAT THE DATA IS CD DATA
SET A FLAG INDICATING THAT THE INTERSECTION IS DELETED
219
SET A FLAG INDICATING THAT THE DATA IS IC CARD DATA
RETURN

Fig.29

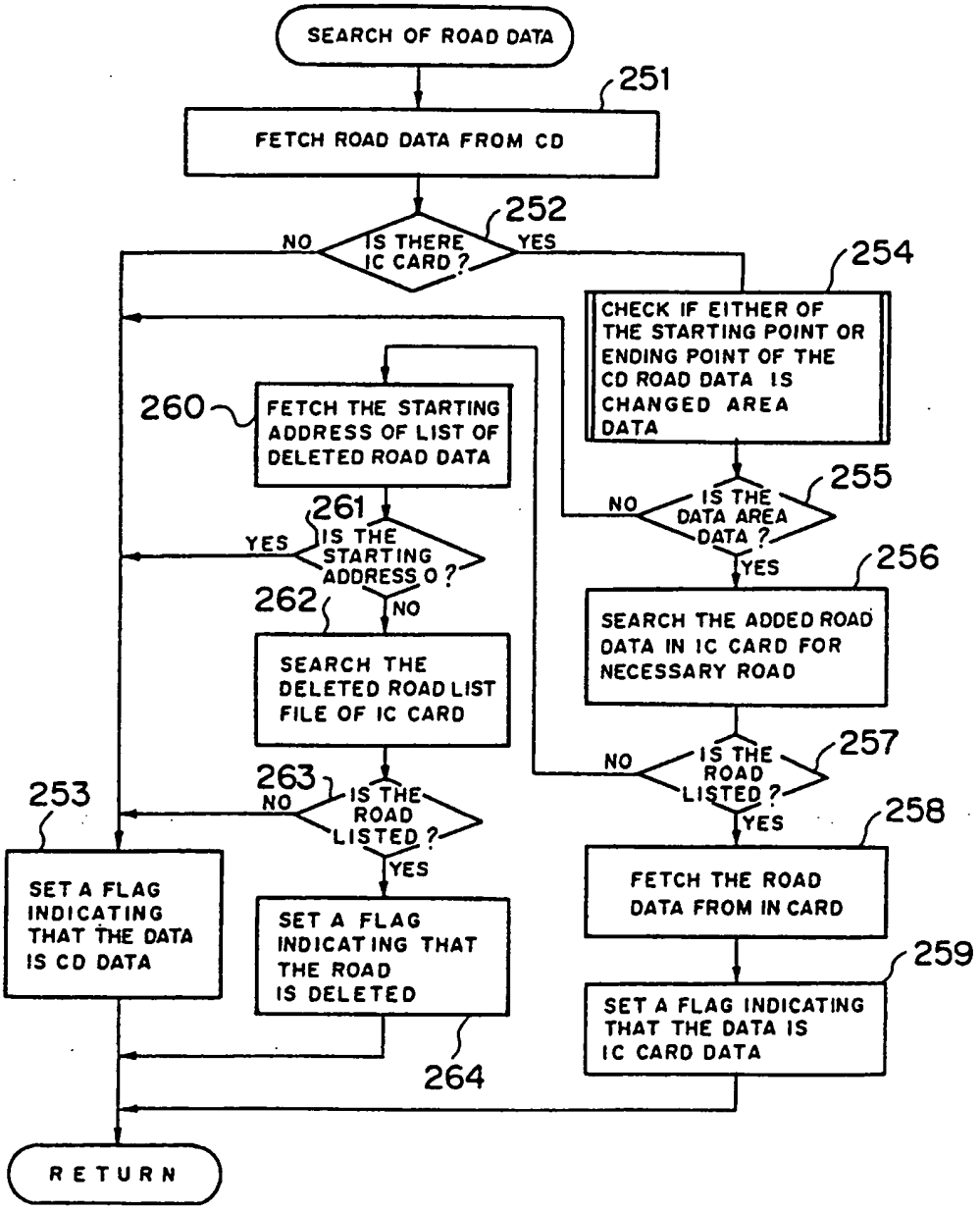

SEARCH OF ROAD DATA
251
FETCH ROAD DATA FROM CD
252
NO
IS THERE IC CARD ?
YES
254
CHECK IF EITHER OF THE STARTING POINT OR ENDING POINT OF THE CD ROAD DATA IS CHANGED AREA DATA
260
FETCH THE STARTING ADDRESS OF LIST OF DELETED ROAD DATA
255
NO
IS THE DATA AREA DATA ?
YES
261
YES
IS THE STARTING ADDRESS 0 ?
NO
256
SEARCH THE ADDED ROAD DATA IN IC CARD FOR NECESSARY ROAD
262
SEARCH THE DELETED ROAD LIST FILE OF IC CARD
257
NO
IS THE ROAD LISTED ?
YES
263
NO
IS THE ROAD LISTED ?
YES
253
258
SET A FLAG INDICATING THAT THE DATA IS CD DATA
SET A FLAG INDICATING THAT THE ROAD IS DELETED
FETCH THE ROAD DATA FROM IN CARD
259
SET A FLAG INDICATING THAT THE DATA IS IC CARD DATA
264
RETURN

Fig.30 (a)

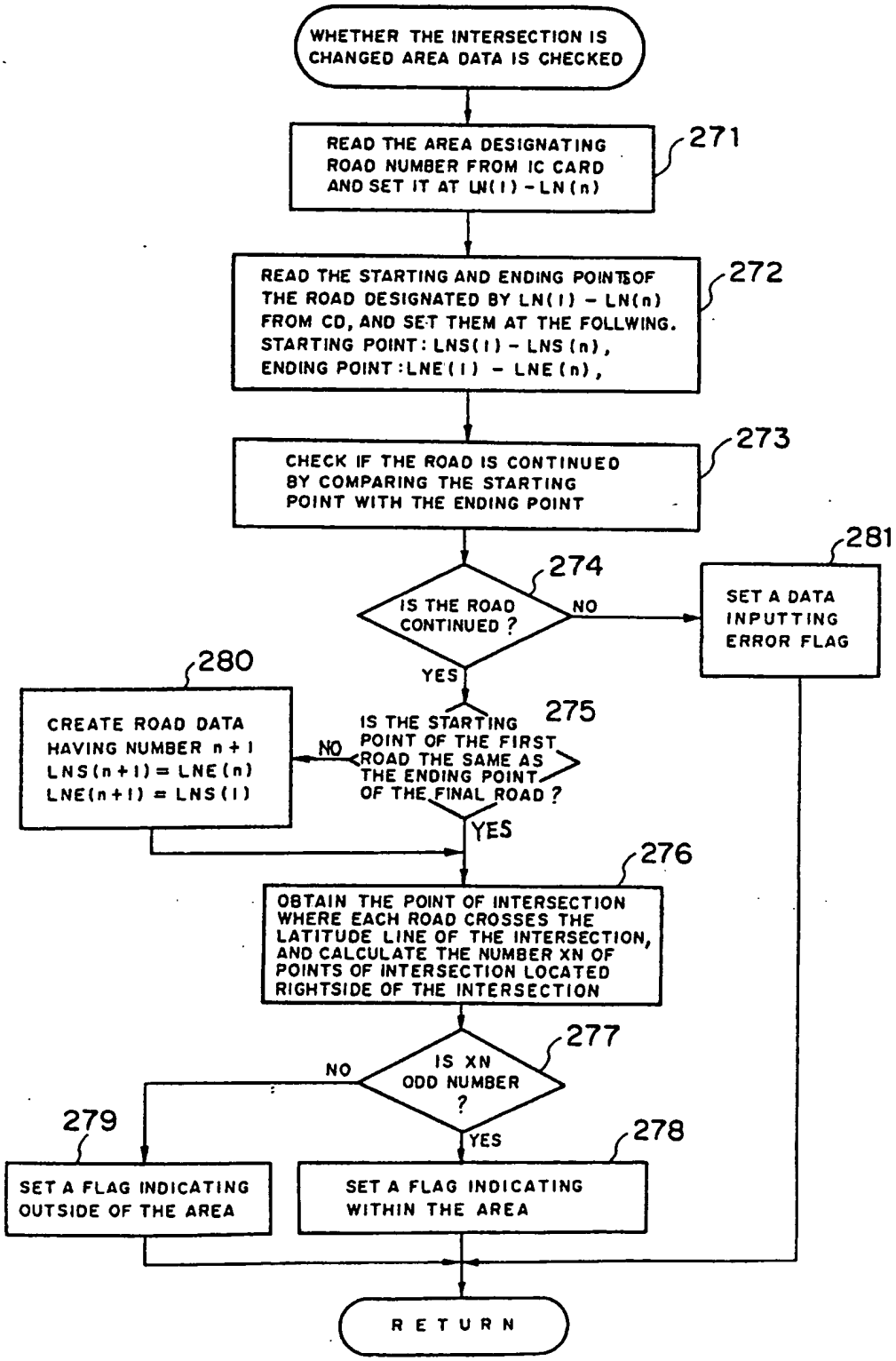
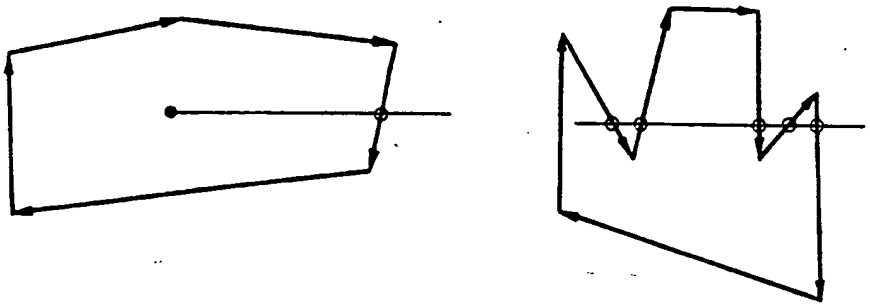
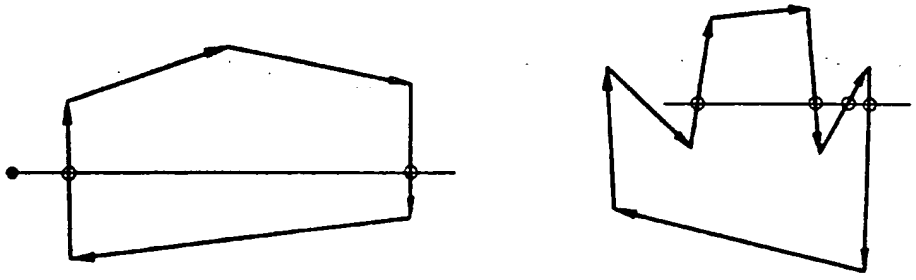

WHETHER THE INTERSECTION IS CHANGED AREA DATA IS CHECKED
READ THE AREA DESIGNATING ROAD NUMBER FROM IC CARD AND SET IT AT LN(1) - LN(n)
271
READ THE STARTING AND ENDING POINTS OF THE ROAD DESIGNATED BY LN(1) - LN(n) FROM CD, AND SET THEM AT THE FOLLWING. STARTING POINT: LNS(1) - LNS(n), ENDING POINT: LNE(1) - LNE(n),
272
CHECK IF THE ROAD IS CONTINUED BY COMPARING THE STARTING POINT WITH THE ENDING POINT
273
IS THE ROAD CONTINUED ?
274
NO
SET A DATA INPUTTING ERROR FLAG
281
YES
IS THE STARTING POINT OF THE FIRST ROAD THE SAME AS THE ENDING POINT OF THE FINAL ROAD ?
275
NO
CREATE ROAD DATA HAVING NUMBER n+1
LNS(n+1) = LNE(n)
LNE(n+1) = LNS(1)
280
YES
OBTAIN THE POINT OF INTERSECTION WHERE EACH ROAD CROSSES THE LATITUDE LINE OF THE INTERSECTION, AND CALCULATE THE NUMBER XN OF POINTS OF INTERSECTION LOCATED RIGHTSIDE OF THE INTERSECTION
276
IS XN ODD NUMBER ?
277
NO
YES
SET A FLAG INDICATING WITHIN THE AREA
278
SET A FLAG INDICATING OUTSIDE OF THE AREA
279
RETURN

Fig. 30 (b)

(A) WITHIN THE AREA



(B) OUTSIDE OF THE AREA



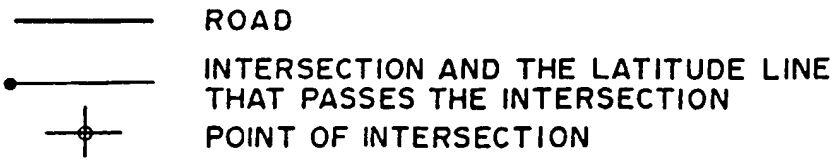


Fig. 31

GEOGRAPHY DATA

NUMBER			150	
NAME OF DATA			ANJO	
THE HIGHEST LATITUDE			+ 35.00	
THE LOWEST LATITUDE			+ 34.90	
THE HIGHEST LONGITUDE			+137.00	
THE LOWEST LONGITUDE			+136.90	
ADJACENT SCREENS	G 1		141	
	G 2		142	
	⋮		⋮	
	G 8		169	
SCREEN DATA	a_{11}	a_{12}	7	7
	a_{13}	a_{14}	7	8
	a_{15}	a_{16}	8	8
	⋮		⋮	
	a_{mn-3}	a_{mn-2}	1	F
	a_{mn-1}	a_{mn}	F	F
NUMBER OF THE WIDE AREA VIEW WHICH CONTAIN THE AREA OF THIS DRAWING			15	
ENLARGED VIEW OF THE PORTION IN THE AREA OF THIS DRAWING	NO. OF DRAWINGS		5	
	NUMBER		1025	
			⋮	

ADJACENT SCREENS

G 1	G 2	G 3
G 4		G 5
G 6	G 7	G 8

SCREEN DATA STRUCTURE

a_{11}	a_{12}	a_{13}	----------	a_{10}
a_{21}	a_{22}	a_{23}	----------	a_{20}
a_{31}	a_{32}	a_{33}	----------	a_{30}
			⋱	⋮
a_{m1}	a_{m2}	a_{m3}	----------	a_{mn}

COLOR NUMBER

COLOR NUMBER	COLOR
WHITE	0
BLACK	1
⋮	⋮
SKY BLUE	F

Fig.32

STARTING ADDRESS OF COMPARISION LIST DATA

NAME OF DATA	ADDRESS
GEOGRAPHY DATA	00FF00

COMPARISON LIST OF GEOGRAPHY DATA

GEOGRAPHY DATA NUMBER	ORDER OF CHANGED DATA
1024	0
1025	1
1026	0
1027	2
1028	-1

STARTING ADDRESS OF CHANGED DATA

NAME OF DATA	ADDRESS
GEOGRAPHY DATA	050000

GEOGRAPHY DATA (ADDED DATA)

NUMBER		1 — 1
NAME OF DATA		SAKURAI-CHO
THE HIGHEST LATITUDE		+34.97
⋮		⋮
NUMBER OF THE WIDE AREA VIEW WHICH CONTAINS THE AREA OF THIS DRAWING		150
ENLARGED VIEW OF THE PORTION OF THE AREA OF THIS DRAWING		0
NUMBER		1025
NAME OF DATAI		ANJO
⋮		⋮
ADJACENT SCREENS	G1	1020
	⋮	⋮
	G7	1 — 1
	G8	0
⋮		⋮
NUMBER		1027
NAME OF DATA		OKAZAKI STATION

Fig.34

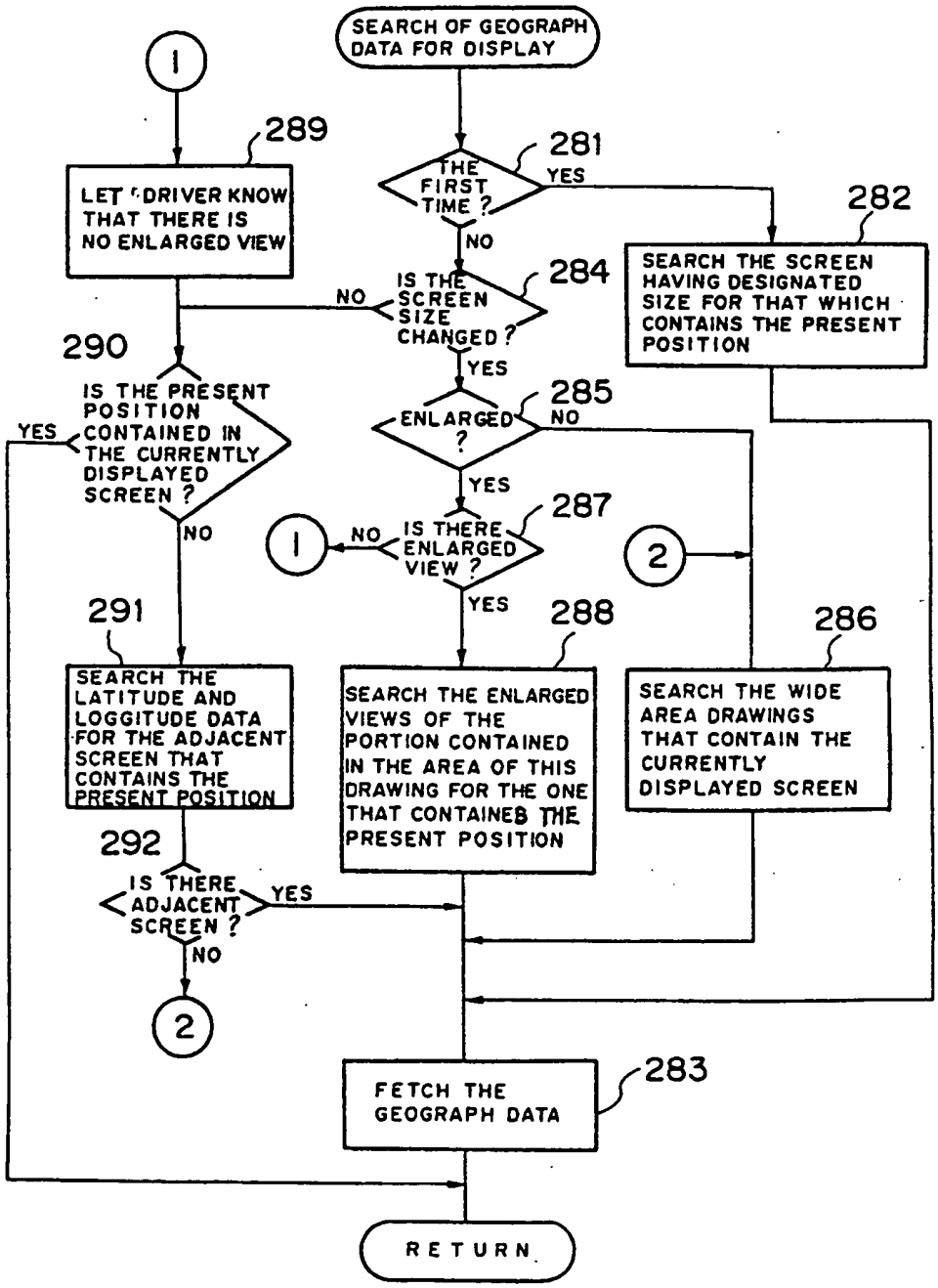

SEARCH OF GEOGRAPH DATA FOR DISPLAY
1
289
LET DRIVER KNOW THAT THERE IS NO ENLARGED VIEW
281
THE FIRST TIME ?
YES
282
SEARCH THE SCREEN HAVING DESIGNATED SIZE FOR THAT WHICH CONTAINS THE PRESENT POSITION
NO
284
IS THE SCREEN SIZE CHANGED ?
NO
290
IS THE PRESENT POSITION CONTAINED IN THE CURRENTLY DISPLAYED SCREEN ?
YES
YES
285
ENLARGED ?
NO
NO
YES
287
IS THERE ENLARGED VIEW ?
1
NO
2
YES
291
SEARCH THE LATITUDE AND LOGGITUDE DATA FOR THE ADJACENT SCREEN THAT CONTAINS THE PRESENT POSITION
288
SEARCH THE ENLARGED VIEWS OF THE PORTION CONTAINED IN THE AREA OF THIS DRAWING FOR THE ONE THAT CONTAINEB THE PRESENT POSITION
286
SEARCH THE WIDE AREA DRAWINGS THAT CONTAIN THE CURRENTLY DISPLAYED SCREEN
292
IS THERE ADJACENT SCREEN ?
YES
NO
2
283
FETCH THE GEOGRAPH DATA
RETURN

Fig.35

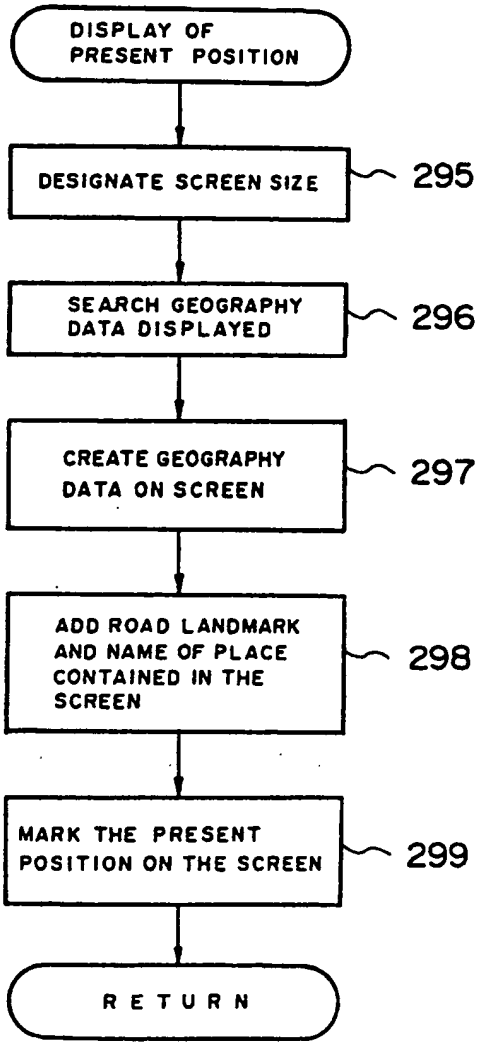

DISPLAY OF PRESENT POSITION
DESIGNATE SCREEN SIZE
295
SEARCH GEOGRAPHY DATA DISPLAYED
296
CREATE GEOGRAPHY DATA ON SCREEN
297
ADD ROAD LANDMARK AND NAME OF PLACE CONTAINED IN THE SCREEN
298
MARK THE PRESENT POSITION ON THE SCREEN
299
RETURN

Fig.36

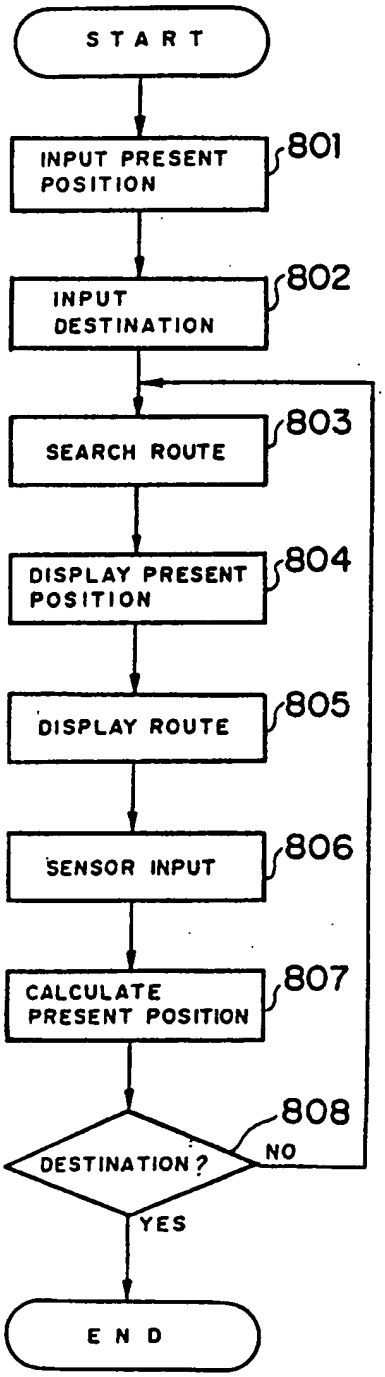
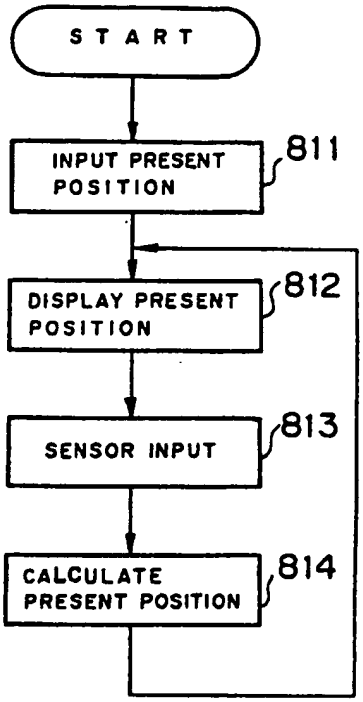

START
INPUT PRESENT POSITION
801
INPUT DESTINATION
802
SEARCH ROUTE
803
DISPLAY PRESENT POSITION
804
DISPLAY ROUTE
805
SENSOR INPUT
806
CALCULATE PRESENT POSITION
807
DESTINATION ?
808
NO
YES
END

Fig.37


START
INPUT PRESENT POSITION
811
DISPLAY PRESENT POSITION
812
SENSOR INPUT
813
CALCULATE PRESENT POSITION
814